
# NAVAL POSTGRADUATE SCHOOL

**MONTEREY, CALIFORNIA**

# THESIS

**CHEMICALLY ENHANCED TRUST: POTENTIAL LAW ENFORCEMENT AND MILITARY APPLICATIONS FOR OXYTOCIN**

by

David R. Dethlefs

December 2007

Thesis Advisor: Dorothy Denning
Thesis Co-Advisor: Craig Hooper

**Approved for public release; distribution is unlimited.**

THIS PAGE INTENTIONALLY LEFT BLANK

| REPORT DOCUMENTATION PAGE | | | Form Approved OMB No. 0704-0188 |
|---|---|---|---|
| Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503. | | | |
| **1. AGENCY USE ONLY** ***(Leave blank)*** | **2. REPORT DATE** December 2007 | **3. REPORT TYPE AND DATES COVERED** Master's Thesis | |
| **4. TITLE AND SUBTITLE** Chemically Enhanced Trust: Potential Law Enforcement and Military Applications for Oxytocin | | | **5. FUNDING NUMBERS** |
| **6. AUTHOR(S)** Major David R. Dethlefs | | | |
| **7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)** Naval Postgraduate School Monterey, CA 93943-5000 | | | **8. PERFORMING ORGANIZATION REPORT NUMBER** |
| **9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)** N/A | | | **10. SPONSORING/MONITORING AGENCY REPORT NUMBER** |
| **11. SUPPLEMENTARY NOTES** The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. | | | |
| **12a. DISTRIBUTION / AVAILABILITY STATEMENT** Approved for public release; distribution is unlimited. | | | **12b. DISTRIBUTION CODE** A |


**13. ABSTRACT (maximum 200 words)**

This research effort explores the potential uses for oxytocin in both law enforcement and military scenarios. These situations are time-sensitive and require rapid trust-building in order to achieve successful and positive outcomes. The trust-inducing properties of oxytocin could prove crucial in providing enhanced trust-building capability; thus, increasing the likelihood of non-violent conclusion of several common law enforcement and military scenarios. This thesis first explores the complexity of both neuroanatomy and neurochemistry, vital foundation material necessary to understanding how oxytocin can be used in the law enforcement and military environments. Oxytocin's potential law enforcement and military applicability is then explored through six scenarios: child witness/victim interviews, suicide attempt response, hostage crisis negotiation, covert infiltration, riot control, inmate rehabilitation and insurgency resolution. The reviewed data supports the potential applicability in all situations except insurgency resolution, where international treaties may forbid its use against foreign populations.


| **14. SUBJECT TERMS** oxytocin, law enforcement, trust, trusting behavior | | | **15. NUMBER OF PAGES** 129 |
|---|---|---|---|
| | | | **16. PRICE CODE** |
| **17. SECURITY CLASSIFICATION OF REPORT** Unclassified | **18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified | **19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified | **20. LIMITATION OF ABSTRACT** UU |

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

**Approved for public release; distribution is unlimited.**

# CHEMICALLY ENHANCED TRUST: POTENTIAL LAW ENFORCEMENT AND MILITARY APPLICATIONS FOR OXYTOCIN

David R. Dethlefs
Major, United States Air Force
B.A., Naval Postgraduate School, 2007

Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF ARTS IN NATIONAL SECURITY STUDIES**

from the

**NAVAL POSTGRADUATE SCHOOL**
**December 2007**

Author: David R. Dethlefs

Approved by: Dorothy Denning
Thesis Advisor

Craig Hooper
Co-Advisor

Douglas Porch
Chairman, Department of National Security Affairs

THIS PAGE INTENTIONALLY LEFT BLANK

# ABSTRACT

This research effort explores the potential uses for oxytocin in both law enforcement and military scenarios. These situations are time-sensitive and require rapid trust-building in order to achieve successful and positive outcomes. The trust-inducing properties of oxytocin could prove crucial in providing enhanced trust-building capability, thus increasing the likelihood of non-violent conclusion of several common law enforcement and military scenarios. This thesis first explores the complexity of both neuroanatomy and neurochemistry, vital foundation material necessary to understanding how oxytocin can be used in the law enforcement and military environments. Oxytocin's potential law enforcement and military applicability is then explored through six scenarios: child witness/victim interviews, suicide attempt response, hostage crisis negotiation, covert infiltration, riot control, inmate rehabilitation and insurgency resolution. The reviewed data supports the potential applicability in all situations except insurgency resolution, where international treaties may forbid its use against foreign populations.

THIS PAGE INTENTIONALLY LEFT BLANK

# TABLE OF CONTENTS

# LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

# LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

# ACKNOWLEDGMENTS

Great thanks to my advisors, Professors Denning and Hooper, for your unyielding assistance in completing this research effort.

Additional thanks due for periodic boosts to sanity from Sue, Nisara, Professor Gregg and my ice cream maker.

THIS PAGE INTENTIONALLY LEFT BLANK

# I. INTRODUCTION

## A. PURPOSE

This thesis will examine the relationship between trust-building and a naturally-occurring hormone called oxytocin. Trust is an essential component of everyday social life. Recent neurochemistry discoveries have linked the hormone oxytocin to the formation of trust bonds. Several crucial law enforcement and military operations rely on the formation of trust to be successful. Additionally, many operations are time-sensitive, hampered by the extensive trust-building process necessary to defuse potentially dangerous scenarios in order to protect human lives. Examples of law enforcement and military scenarios that require significant and extensive trust-building processes include interviewing child victims/witnesses, rescuing individuals from cry-for-help suicide gestures (the proverbial man-on-the-window-ledge), negotiating hostage crises, infiltrating covert and/or criminal networks and rehabilitating criminal offenders. The objective is to determine the potential effectiveness of oxytocin to enhance trust-building during law enforcement and military scenarios.

The overall question this thesis seeks to answer is: Does the hormone oxytocin provide potentially valuable law enforcement and/or military applications? A subset of related questions includes:

- Does oxytocin contribute to trust?
- Can oxytocin more predictably produce the observable phenomenon of trust during critical law enforcement and/or military scenarios?
- Is the trust-building process significantly shortened through the use of oxytocin?

## B. IMPORTANCE

Reducing the amount of time necessary to build trust between law enforcement and/or military personnel and victims or perpetrators could yield significant safety and life-saving benefits. Significant attention is given to trust-building during high-intensity

and time-sensitive operations such as hostage negotiations and victim interviews. The extensive amount of time necessary to build effective trust relationships lengthens the amount of time that innocent people remain in harm's way. Therefore, techniques that significantly shorten the trust-building phase of such operations could help to increase the overall safety of people in threatening situations.

Ironically, we know so little about some of the most prevalent aspects of life. The concept of trust certainly falls into this category. As Horton states: "What is trust? Little is known scientifically, but it pervades human existence."[1] In critical or life-threatening situations, trust moves closer to the forefront. For law enforcement and military personnel, trust can be the deciding factor between peaceful or violent resolution of a situation.

## C. TRUST

Trust is a fundamental feature of social interaction. The concept of trust is a powerful one, and the importance of trust in society is immense, as indicated by the vehemence of statements referencing trust:

> We will not argue the absolutely crucial role of trust for the whole human social life and interaction. This would be too obvious.[2]

> Humans are so given to trust that it comprises its own category of knowledge….one cannot live without trust in others and events.[3]

> With a complete absence of trust, one must be catatonic, one could not even get up in the morning.[4]

---

[1] James L., Horton. "Trust, Reason and Relations" [article on-line]. NYC: Millican, Marston and Associates, 2004, accessed 22 August 2007; available from http://www.online-pr.com/Holding/Trust_Reason_and_Relations__REVISED.pdf; Internet.

[2] Cristiano Castelfranchi and Rino Falcone. "Principles of Trust for MAS: Cognitive Anatomy, Social Importance and Quantification" [article on-line]. Rome, Italy: National Research Council, 1999, accessed 22 August 2007; available from http://aois.org/99/castelfranchi-ICMAS-paper.rtf; Internet.

[3] James L. Horton. "Trust, Reason and Relations" [article on-line]. NYC: Millican, Marston and Associates, 2004, accessed 22 August 2007; available from http://www.online-pr.com/Holding/Trust_Reason_and_Relations__REVISED.pdf; Internet.

[4] Piotr Sztompka. *Trust: A Sociological Theory*. Cambridge, UK: Cambridge University Press, 1999.

To be trusted is a greater compliment than to be loved.[5]

Trust is prevalent in everyday life. Nearly every feature of social interaction depends in some way on trust or distrust. "Basic trust is something we develop in a crude form in infancy and continue to refine throughout our lives."[6] The extent to which one develops an ability or inability to trust can have profound impacts on one's life: "An infant whose mother or other caregivers reliably provided such a secure base will tend to develop a secure and confident attitude toward the world, whereas those who lack such a critical early experience will tend toward chronic anxiety."[7] Building on this concept, a study between individuals with a high propensity to trust and individuals with a low propensity to trust demonstrated that individuals with a high propensity to trust are more adept at gaining personal benefits.[8] Trust, therefore, provides significant advantages for the individual. In this perspective, "trust is a simplifying strategy that enables individuals to adapt to complex social environment, and thereby benefit from increased opportunities."[9]

While trust influences several factors of our lives (such as anxiety levels and the ability to form strong social bonds), environmental and biological factors also influence our ability to trust. A large-scale study conducted by the National Science Foundation and the Massachusetts Institute of Technology yielded some interesting data about how environmental and biological factors influence how we trust. Environmental factors such as city size, education level, wealth and marital status demonstrated considerable effects on ability to trust. City size negatively affected likelihood to trust, while education level

---

[5] George MacDonald. *Unspoken Sermons*. London: Golden Key Publishing, 1867.

[6] Lawrence C. Becker. "Trust as Non-cognitive Security About Motives" [article on-line]. Chicago, IL: University of Chicago Press, 1996, accessed 22 August 2007; available from http://www.jstor.org/view/00141704/di994964/ 99p00905/0; Internet; 46.

[7] Barbara Smuts. "How Do Other Animals Get Security and Trust?" [article on-line]. San Francisco, CA: Point Foundation, 2002, accessed 22 August 2007; available from http://findarticles.com/p/articles/mi_m0GER/is_2002_Fall/ai_ 93135758/pg_6; Internet.

[8] Karen S. Cook and Robin M. Cooper. "Experimental Studies of Cooperation, Trust and Social Exchange." In *Trust and Reciprocity*, ed. Elinor Ostrom and James Walker, 209-243. NYC: Russell Sage Foundation, 2003, 221.

[9] Timothy Earle and George T. Cvetkovich. *Social Trust: Toward a Cosmopolitan Society*. NYC: Praeger Publishing, 1995; 38.

and wealth positively affected likelihood to trust. Additionally, married individuals are more likely to exhibit trusting behavior than single people. Race also impacted trusting behavior. Black people showed considerably less propensity to trust than white people. Contrary to popular stereotypes, the study also showed that men were more likely to trust than women and younger people were less trusting than older people.[10]

Trust can also provide significant interpersonal advantages: "Trust increases efficiency in human interaction."[11] Trust is the foundation for the formation of society, economic transactions, information-sharing and a host of other crucial interpersonal functions. "Trust shapes the willingness to accept risk."[12] Trust also mitigates anxiety and stress resulting from the myriad of influences that bombard each individual everyday. Without the willingness to accept risk, people would live in a constant catatonic state, as described in one of the quotes above.

While trust can be viewed as a coping mechanism for uncertainty and risk, the opposite perspective has also been posited: "Trusting behavior consists of actions that increase one's vulnerability to another whose behavior is not under one's control in a situation where the penalty one suffers if the other abuses that vulnerability is greater than the benefit one gains if the other does not abuse that vulnerability."[13] Russell Hardin, a leading theorist on trust, corroborates this view when he states that "virtually all writers on trust agree, acting on trust involves giving discretion to another to affect one's interests. This move is inherently subject to risk…."[14] While trust relationships do inherently involve uncertainty and risk, trust is most prevalently viewed by prominent academia as a positive force that mitigates *overall* uncertainty and risk. As Piotr Sztompka states, "Trusting becomes the crucial strategy for dealing with an uncertain and

---

[10] Edward L. Glaesser, David I. Laibson, Jose A. Scheinkman and Christine L. Soutter. "Measuring Trust" [article on-line]. Cambridge, MA: MIT Press, 2000, accessed 22 August 2007; available from http://www.jstor.org/view/00335533/di011633/01p0133c/0; Internet.

[11] Vincent Buskens and Werner Raub. "Embedded Trust: Control and Learning." In *Group Cohesion, Trust and Solidarity*, ed. Shane R. Thye and Edward J. Lawler, 167-202. Oxford, UK: Elsevier Science Ltd, 2002; 168.

[12] Tom R. Tyler. "Why Do People Rely on Others? Social Identity and Social Aspects of Trust." In Trust in Society, ed. Karen S. Cook, 285-306. NYC: Russell Sage Foundation, 2001; 285.

[13] Bart Nooteboom. *Trust*. Northampton, MA: Edward Elgar Publishing, Inc, 2002; 37.

[14] Russell Hardin. *Trust and Trustworthiness*. NYC: Russell Sage Foundation, 2002, 11.

uncontrollable future. In situations when we have to act in spite of uncertainty and risk, trust comes to the fore."[15] Diego Gambetta concurs: "Trust is particularly relevant in conditions of ignorance or uncertainty with respect to unknown or unknowable actions of others."[16] Finally, Niklas Luhmann states that "trust is a solution to specific problems of risk."[17] These perspectives seem to be backed by the general perception of trust as a positive human and societal element—most people generally perceive trust as a good thing.

Another popularly conceived notion about trust is that of cognitive trust, the belief that trust occurs from a purely conscious decision-making process.[18] One of the most ardent believers in singularly cognitive trust is theorist Russell Hardin. Hardin even dedicates an entire chapter of his book (Chapter 3: "Conceptions and Misconceptions") toward refuting all theories that de-emphasize the cognitive aspect of trust.[19] Despite his efforts to debunk theories about non-cognitive aspects of trust, Hardin provides several strong statements within his own arguments that seem to refute his own belief that trust is purely cognitive. For example, Hardin offers the perspective that "trust is not a primitive….rather, it is reducible to other things that go into determining trust."[20] With this statement, Hardin allows for the possibility that trust is comprised of many factors and elements that contribute toward overall trust. Additionally, Hardin states: "My trust of you can neither be offered nor withheld. Similarly, you can neither accept nor refuse my trust."[21] This statement implies that the act of trusting is devoid of choice, which completely rules out any room for conscious decision-making in trust scenarios. This statement categorically contradicts Hardin's earlier position against non-cognitive

---

[15] Piotr Sztompka. *Trust: A Sociological Theory*. Cambridge, UK: Cambridge University Press, 1999, 25.

[16] Diego Gambetta. "Can We Trust Trust?" In *Trust: Making and Breaking Cooperative Relationships*, ed. Diego Gambetta, 213-237. Oxford: Basil Blackwell, 1988, 218.

[17] Niklas Luhmann. "Familiarity, Confidence, Trust: Problems and Alternatives." In *Trust: Making and Breaking Cooperative Relationships*, ed. Diego Gambetta, 94-107. Oxford: Basil Blackwell, 1988, 95.

[18] Russell Hardin. *Trust and Trustworthiness*. NYC: Russell Sage Foundation, 2002, 7.

[19] Ibid., 54-87.

[20] Ibid., 57.

[21] Ibid., 58.

elements of trust-building. These two contradictory statements in Hardin's argument suggest that trust inherently contains its own duality—both cognitive (consciously controllable) and non-cognitive (subconsciously automated) aspects.

## D. NON-COGNITIVE TRUST

The idea that our brains perform functions that we are not even aware of might come across as discomforting to some people. The prevailing perception is that humans are in complete control—that logic and reason allow humans to exercise absolute control over our own actions. However, a growing body of scientific research continues to erode this perception by uncovering the previously hidden operations that influence our behavior and provide motivations for our actions and emotions.

Not surprisingly, most research (and subsequent knowledge) about trust concentrates on the cognitive aspect of trust.[22] However, trust also contains a non-cognitive component. In fact, "non-cognitive trust is a common phenomenon."[23] Non-cognitive trust can be defined as that component of trust that does not enter our conscious mind, manifested in situations where there is no active decision-making process to determine level of trust. Non-cognitive trust manifests itself in many ways. We trust that the floor will not fall out from under us when we take a step, and we trust that a chair will support our weight when we sit down. These trust scenarios are assumed. Unless we have evidence to the contrary, trust is automatic and does not breach the threshold from the subconscious mind to the conscious mind. There is evidence that non-cognitive trust even develops before cognitive trust.[24]

Non-cognitive brain functions are more common that one might expect. Consider the old adage that we only use ten percent of our brain. On the contrary, we utilize 100% of our brain; however, only about ten percent of our brain is dedicated to conscious

---

[22] Lawrence C. Becker. "Trust as Non-cognitive Security About Motives" [article on-line]. Chicago, IL: University of Chicago Press, 1996, accessed 22 August 2007; available from http://www.jstor.org/view/00141704/di994964/ 99p00905/0; Internet; 43.

[23] Ibid., 50.

[24] Barbara Smuts. "How Do Other Animals Get Security and Trust?" [article on-line]. San Francisco, CA: Point Foundation, 2002, accessed 22 August 2007; available from http://findarticles.com/p/articles/mi_m0GER/is_2002_Fall/ai_ 93135758/pg_6; Internet.

activity while the other 90% controls non-cognitive functions such as regulating heartbeat, ensuring proper hormone levels, controlling hunger and thirst, etc.[25]

Additionally, evidence of non-cognitive intelligence and capabilities has been observed for decades. Sleepwalking is, perhaps, one of the most recognized non-cognitive observable behaviors. While sleepwalking is a relatively familiar non-cognitive behavior, it has been suggested that non-cognitive abilities are even more prominent in our daily lives. In 1943, psychologist David Wechsler proposed that non-cognitive characteristics were more influential in predicting an individual's success in life than cognitive characteristics.[26] Non-cognitive characteristics outshine intelligence in predicting adaptability, job performance, recovery and relationship-building.[27] Following that line of thought, the non-cognitive aspect of trust may be more influential on behavior than cognitive trust.

Why then is there so much dissention about the non-cognitive aspect of trust? The core of this dispute may be a simple matter of semantics. Hardin defines non-cognitive trust as "belief that trust is moral or based on faith."[28] Another prominent theorist on trust, Lawrence Becker, defines non-cognitive trust as a "disposition to be trustful independently of our beliefs or expectations."[29] However, both of these definitions allude directly to cognitive forms of trust. Both Hardin and Becker argue that non-cognitive trust is somehow dependent on morals, faith, beliefs or expectations—all products of a conscious thought process. As stated earlier, the working definition of non-cognitive trust in this paper is trust that does not enter our conscious mind, manifested in situations where there is no active decision-making process to determine level of trust.

---

[25] Christopher Wanjek. *Bad Medicine: Misconceptions and Misuses Revealed, from Distance Healing to Vitamin O*. Hoboken, NJ: Wiley Publishing, 2002; 19.

[26] Cary Cherniss. "Emotional Intelligence: What It Is and Why It Matters" [article on-line]. Piscataway, NJ: Rutgers University, 2000, accessed 22 August 2007; available from http://www.eiconsortium.org/research/what_is_emotional_ intelligence.htm; Internet; 3.

[27] Ibid., 4-5.

[28] Russell Hardin. *Trust and Trustworthiness*. NYC: Russell Sage Foundation, 2002, 66.

[29] Lawrence C. Becker. "Trust as Non-cognitive Security About Motives" [article on-line]. Chicago, IL: University of Chicago Press, 1996, accessed 22 August 2007; available from http://www.jstor.org/view/00141704/di994964/ 99p00905/0; Internet, 50.

Therefore, use of the term 'non-cognitive trust' in this paper differs greatly from usage of the term by these other authors.

This difference leads to a relevant question: how can trust manifest on a non-cognitive level—below the threshold of conscious thought? Hardin alludes to the answer to this question when he refers to a "constantly problematic aspect of social scientific explanations"[30]—that social science cannot encompass the entire spectrum of motivation for trust. This 'problem' is exemplified by observations of trust in "pre-scientific cultures where trust is not based on observation of or contemplation on observable facts."[31] Observations of trust and trust behavior in animals also provide evidence that elements contributing to trust exist on a non-cognitive level.[32] The answer to this question seems to lie outside the realm of social science and, instead, in the field of neurochemistry.

## E. OXYTOCIN

Piotr Sztompka describes three foundations of trust: reflected trustworthiness, trusting impulse and trust culture.[33] Recent scientific discoveries provide evidence of a fourth foundation of trust: physiology.[34] Breakthroughs in neurochemistry have conclusively shown that hormones produced by and used within the central nervous

---

[30] Russell Hardin. *Trust and Trustworthiness*. NYC: Russell Sage Foundation, 2002, 85.

[31] Ibid., 85.

[32] Barbara Smuts. "How Do Other Animals Get Security and Trust?" [article on-line]. San Francisco, CA: Point Foundation, 2002, accessed 22 August 2007; available from http://findarticles.com/p/articles/mi_m0GER/is_2002_Fall/ai_ 93135758/pg_6; Internet and Lester Haines. "Piranhas actually scaredycats, boffins claim" [article on-line]. London: Situation Publishing Ltd., 2007, accessed 9 September 2007; available from http://www.theregister.co.uk/2007/07/02/piranha_legend_debunked/; Internet.

[33] Piotr Sztompka. *Trust: A Sociological Theory*. Cambridge, UK: Cambridge University Press, 1999; 101.

[34] M. Kosfeld, M. Heinrichs, P. Zak, U. Fischbacher and E. Fehr. "Oxytocin Increases Trust in Humans." *Nature* 435 (2005):673-676; P. Kirsch, C. Esslinger, Q. Chen, D. Mier, S. Lis, S. Siddhanti, H. Gruppe, V. S. Mattay, B. Gallhoffer and A. Meyer-Lindenberg. "Oxytocin Modulates Neural Circuitry for Social Cognition and Fear in Humans." *Journal of Neuroscience* 25 (December 2005):11489-93; Keith M. Kendrick. "The Neurobiology of Social Bonds" [article on-line]. London: British Society for Neuroendocrinology, 2006, accessed 13 October 2007; available from http://neuroendo.org.uk/index.php/content/view/34/11/; Internet; M. R. Thompson,. P. D. Callaghan, G. E. Hunt, J. L. Cornish, I. S. McGregor. "A role for oxytocin and 5-HT(1A) receptors in the prosocial effects of 3,4 methylenedioxymethamphetamine ("ecstasy")." *Neuroscience* 146 (March 2007):509-14; H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006.

system contribute significantly to emotions, perceptions and observable behaviors—often without the conscious knowledge of these effects by the individual.[35] One such hormone is oxytocin, a biological compound produced by the hypothalamus, dispersed through the pituitary gland and used extensively by the amygdala, ventromedial hypothalamus, septum and brainstem.[36]

Oxytocin has been a commonly known hormone for many years, primary in relation to physiological purposes such as lactation, uterine contractions and orgasm.[37] Recent neurochemistry discoveries such as the studies referenced above have demonstrated that oxytocin is far more influential in overall physical functioning of the human body. For example, oxytocin plays significant roles in sexual arousal, bonding, maternal behavior, trust/fear reactions, reduction of addictive behaviors and preparing the fetus for birth.[38]

---

[35] H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006; *Boston Globe*. "To Sniff at Danger." [article on-line]. Boston: *Boston Globe*, 2006, accessed 13 October 2007; available from http://www.smh.com.au/news/mind-matters/to-sniff-at-danger/2006/01/12/1136956247384.html; Internet; *Economist*. "I Get a Kick out of You: Scientists Are Finding that, After All, Love Really Is Down to a Chemical Addiction Between People." [article on-line.] London: *The Economist*, 2004, accessed 13 October 2007; available from http://www.oxytocin.org/oxytoc/love-science.html; Internet; Kevin M. Kendrick. "The Neurobiology of Social Bonds" [article on-line]. London: British Society for Neuroendocrinology, 2006, accessed 13 October 2007; available from http://neuroendo.org.uk/index.php/content/view/34/11/; Internet.

[36] Martin, John H. *Neuroanatomy: Text and Atlas.* NYC: McGraw-Hill, 2003*;* 353, 357.

[37] Thomson Healthcare, Physicians' Desk Reference (Montvale, NJ: Thomson Healthcare, 2007): MD07645; RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet.

[38] RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet; Kevin M. Kendrick. "The Neurobiology of Social Bonds" [article on-line]. London: British Society for Neuroendocrinology, 2006, accessed 13 October 2007; available from http://neuroendo.org.uk/index.php/content/view/34/11/; Internet; M. Kosfeld, M. Heinrichs, P. Zak, U. Fischbacher and E. Fehr. "Oxytocin Increases Trust in Humans." *Nature* 435 (2005):673-676; P. Kirsch, C. Esslinger, Q. Chen, D. Mier, S. Lis, S. Siddhanti, H. Gruppe, V. S. Mattay, B. Gallhoffer and A. Meyer-Lindenberg. "Oxytocin Modulates Neural Circuitry for Social Cognition and Fear in Humans." *Journal of Neuroscience* 25 (December 2005):11489-93; M. R. Thompson,. P. D. Callaghan, G. E. Hunt, J. L. Cornish, I. S. McGregor. "A role for oxytocin and 5-HT(1A) receptors in the prosocial effects of 3,4 methylenedioxymethamphetamine ("ecstasy")." *Neuroscience* 146 (March 2007):509-14; H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006.

| Form of Trust | Object of Trust |
|---|---|
| Behavioral Trust | An actor |
| Material Trust | Means, input |
| Competence Trust | Ability, skills, knowledge, methods |
| Intentional Trust | Aims, intentions |
| dedication trust | Dedication/care |
| benevolence trust | Benevolence, goodwill |
| Conditional Trust | Outside enablers, constraints |
| Exemplar Trust | Role models |
| Informational Trust | Information |
| honesty trust | Truthfulness |

Table 1. Elements of Behavioral Trust (taken from Nooteboom, 2002)

When produced and used naturally by the central nervous system, oxytocin contributes to a classification of trust called behavioral trust,[39] one of seven categorized forms of trust (see Table 1). However, a question posed by trust theorists—even more relevant with such recent neurochemistry discoveries—centers on precisely how trust develops.[40] It has been posited that trust develops on three levels: the macro level ("values, norms and standards of the institutional environment"),[41] the meso level (organization within society),[42] and the micro level (specific relations).[43] Oxytocin, however, seems to develop trust at an even more basic level, the molecular level.

[39] Bart Nooteboom. *Trust*. Northampton, MA: Edward Elgar Publishing, Inc, 2002; 50

[40] Ibid., 84

[41] Ibid., 86

[42] Ibid., 87

[43] Ibid., 87

| Basis | Examples |
|---|---|
| Characteristics-based trust | Membership of family, community, culture, religion |
| Institutions-based trust | Rules, ethics, professional standards |
| Process-based trust | Loyalty, commitment |

Table 2. Modes of Intentional Trust Production (taken from Nooteboom, 2002)

Up to this point, trust has been referred to as a natural process; however, trust can also be intentionally evoked.[44] The evocation of trust supra-naturally would fall under a different classification: conditional trust, which is trust produced or caused by outside enablers or constraints.[45] Modes of intentional trust have previously been broken into three categories: characteristic-based, institution-based and process-based trust[46] (see Table 2). Since oxytocin seems to produce just such a trust-enhancing effect on the human organism (stimulating the three general functions of trust: giving trust, confirming trust and reciprocating trust),[47] oxytocin may constitute induction of a fourth category of intentional trust production: a physiological category (see Table 3).

It is important to note that oxytocin does not produce a zombie-like blind or pathological trust. Instead, oxytocin enhances the trust-building process. As Bart Nooteboom observes: "trust and trustworthiness are adaptive…the threshold [of trust] is adjustable as a function of realized profits."[48] Oxytocin merely provides more room for maneuver in the trust-forming process, generally producing positive trust-building effects.

[44] Bart Nooteboom. *Trust*. Northampton, MA: Edward Elgar Publishing, Inc, 2002; 86

[45] Ibid., 50

[46] Ibid., 86.

[47] Piotr Sztompka. *Trust: A Sociological Theory*. Cambridge, UK: Cambridge University Press, 1999; 103.

| Basis | Examples |
|---|---|
| Characteristics-based trust | Membership of family, community, culture, religion |
| Institutions-based trust | Rules, ethics, professional standards |
| Process-based trust | Loyalty, commitment |
| *Physiological-based trust* | *Neurochemistry, brain structure* |

Table 3. Adjusted Modes of Intentional Trust Production (taken from Nooteboom, 2002)

## F. PHARMACOLOGY OF OXYTOCIN

Oxytocin is a commonly available medication, most often produced under the drug name Pitocin.[49] Given that oxytocin is normally used during childbirth, the drug is widely manufactured by pharmaceutical companies. Oxytocin is available in both injection and nasal spray forms. Oxytocin is ineffective in ingestible forms as digestive fluids destroy the biological compound before it can enter the bloodstream. Oxytocin has a mean lifetime (time period during which a single dosage is effective) of between 2.4 – 8.6 minutes, depending on mitigating factors of individual physiology.

Oxytocin is known to react with two families of drugs: vasoconstrictors and anesthesia. Vasoconstrictors constrict blood vessels in order to treat hypotension (low blood pressure) by increasing blood pressure. When oxytocin is administered within three to four hours after a vasoconstrictor is administered, oxytocin can exaggerate the effects of the vasoconstrictor, resulting in abnormally high blood pressure.[50]

---

[48] Bart Nooteboom. *Trust*. Northampton, MA: Edward Elgar Publishing, Inc, 2002; 175.

[49] Thomson Healthcare, Physicians' Desk Reference (Montvale, NJ: Thomson Healthcare, 2007): MD07645.

[50] RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet.

Oxytocin also reacts with caudal block anesthesia and cyclopropane anesthesia. This phenomenon is usually observed during childbirth, when oxytocin and anesthesia are used during the birthing process. "Severe hypertension has been reported when oxytocin was given three to four hours following prophylactic administration of a vasoconstrictor in conjunction with caudal block anesthesia."[51] Used in conjunction with cyclopropane anesthesia, oxytocin may cause hypotension, abnormally slow heartbeat or irregular rhythm of the atrial heart chambers.[52]

Medications, by their nature, affect normal operations of the human body. Most medications produce side effects in conjunction with the prescribed effect. Oxytocin may also contribute to a range of side effects; however, side effects from oxytocin are fairly irregular since oxytocin is a hormone naturally produced by the human body. As noted above, oxytocin may produce side effects when interacting with other drugs in the system. Additionally, oxytocin may aggravate pre-existing health conditions. Most side effects associated with oxytocin are relatively minor (non life-threatening) such as tachycardia (rapid heart rate), bradycardia (slow heart rate), hyper- or hypotension, angina (chest pain), nausea, vomiting or dyspnea (shortness of breath).[53] Some side effects can be more severe such as seizures or an extreme allergic reaction known as anaphylactic shock.[54] Additionally, the anti-diuretic properties of oxytocin can, in extreme cases, cause hyponatremia (water poisoning).[55] In pregnant or post-pregnancy women, oxytocin can contribute to pelvic hematoma (bruising), uterine rupture or post-

---

[51] RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet.

[52] Ibid.

[53] Thomson Healthcare, Physicians' Desk Reference (Montvale, NJ: Thomson Healthcare, 2007): MD07645 and RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet

[54] Thomson Healthcare, Physicians' Desk Reference (Montvale, NJ: Thomson Healthcare, 2007): MD07645.

[55] Jenn Yeu Wang, Shih Hua Lin, Yuh Feng Lin, Hui Yen Chen, Fu Chiu Yu, Mao Tsu Fu. "An Unforgotten Cause of Acute Hyponatremia: Water Intoxication due to Oxytocin Administration in a Pregnant Woman." *Nephron* 86, no. 3 (April 2000): 342-343.

partum hemorrhage.[56] It is significant to note that extreme side effects to oxytocin are rare. Individuals are more likely to experience an extreme reaction to sugar than to oxytocin.

## G. HYPOTHESIS

This research project will discuss issues relevant to answering whether oxytocin provides valuable real-world benefits to the law enforcement and military fields. At the end of this research project, three main hypotheses will be evaluated. Chapter VI will present evaluations on whether the data sufficiently supports these hypotheses.

Hypothesis #1: Feasible practical applications for oxytocin exist within the law enforcement and military fields. Based on available data, this project will determine whether or not oxytocin can feasibly be utilized in real-world law enforcement and military applications.

Hypothesis #2: Oxytocin reduces the amount of time necessary to build effective trust relationships. As noted earlier, time is critical in many law enforcement and military scenarios. The ability to shorten the trust-building phase would be a major benefit derived from the use of oxytocin. Based on available data, this project will determine whether or not oxytocin can reduce trust-building timelines.

Hypothesis #3: Oxytocin contributes to both trusting and acting on trust. As noted earlier, these are two entirely different things. One can trust, but not act on that trust. In a real-world scenario, it is important that oxytocin contribute to both trusting and acting on that trust, as the latter is contingent on successful conclusion of the scenario. Based on available data, this project will determine whether or not oxytocin affects both dependent variables.

## H. METHODOLOGY

The trust-building effects of oxytocin are a new discovery—so new that novel applications for oxytocin have yet to be determined. So far, the most extensively

[56] RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet.

researched application for oxytocin has been a potential treatment for autism[57] and for addiction.[58] Yet, oxytocin's trust-building effects could yield positive applications outside the medical field. The law enforcement and defense fields stand to gain considerably from potential real-world applications of oxytocin's trust-building effects. Are oxytocin's trust-building effects powerful enough to benefit law enforcement and the military? Can effective administration techniques be developed for law enforcement and military applications? Is the use of oxytocin in such scenarios legal and ethical?

To address these important questions, this thesis proposes a quantitative analysis approach utilizing existing studies on oxytocin and its known effects. The independent variable (IV) will be oxytocin. Studies were chosen based on their compatibility with the subject. For example, studies concentrating oxytocin's effects on bonding, trust-building, fear, anxiety and aggression were deemed relevant studies. On the other hand, studies concerning oxytocin's effects on sexual arousal and drug tolerance were deemed incompatible with this project's goals.

Pre-existing data from medical studies on oxytocin and related neurochemicals such as vasopressin, serotonin and adrenaline will be analyzed to determine specific observable effects of oxytocin in relation to trust-building and fear/anxiety abatement. The degree to which oxytocin can shorten the trust-building timeline will be evaluated. Additionally, expected side benefits (such as empathy) will be examined. I believe significant and realistic law enforcement and military applications can be developed for oxytocin. Analysis of available medical data should reveal a causal relationship between oxytocin and an expedited trust-building process. Empirical analysis should validate this theory and offer a better understanding of real-world applications that benefit public safety. (The nature, extent, and duration of this relationship are unknown at this time.)

---

[57] E. Hollander, J. Bartz and W. Chaplin. "Oxytocin increases retention of social cognition in autism". *Biological Psychiatry* 61, no. 4 (2007): 498–503; C. Modahl, L. Green and D. Fein. "Plasma oxytocin levels in autistic children". *Biological Psychiatry* 43, no. 4 (2007): 270–277.

[58] G. L. Kovacs, Z. Sarnyai and G. Szabo. "Oxytocin and Addiction: a Review." *Psychoneuroendocrinology* 23 (1998): 945-962; Thompson. M. R., P. D. Callaghan, G. E. Hunt, J. L. Cornish, I. S. McGregor. "A role for oxytocin and 5-HT(1A) receptors in the prosocial effects of 3,4 methylenedioxymethamphetamine ("ecstasy")." *Neuroscience* 146 (March 2007):509-14

## I. PREVIEW OF CONTENT

The following chapters will provide an in-depth review of data on oxytocin and its effects on trust-building. There are five follow-on chapters. Chapters II and III provide further background material. Chapter II examines medical studies relevant to oxytocin and trust. Chapter III examines trust from the perspective of elements that act to degrade trust such as fear, anxiety and aggression. Chapter IV examines the practical applicability of oxytocin in the law enforcement and military fields. Potential law enforcement and military applications will be presented in this chapter along with suggested methods of administration. Chapter V discusses legal and ethical implications of using a biological agent for law enforcement and military means. An objective discussion of pertinent human/civil rights and legal issues will be presented. Finally, Chapter VI will present conclusions and recommendations based on the implications of the evidence.

# II. MEDICAL DATA

One of the greatest disputes between physical and social sciences is whether nature or nurture has the greater influence over human behavior. The nature versus nurture debate experienced a severe jolt during the last four years due to recent biological breakthroughs in neurochemistry and physiology. For example, a Harvard Medical School study on mice determined that the *fos* family of genes "heavily influences—if not downright controls—whether a mouse nurtures her offspring."[59] This was one of the first studies to directly link biology and physiology to behavior.

Beyond genetics, hormones and chemical peptides in the body demonstrate the power to influence behavior. More specifically, neuro-chemicals produced in the brain were once thought to affect only the localized synaptic region.[60] However, "it is becoming increasingly clear that putative transmitters are capable of a wider range of action, both with regard to duration of action and distance between release sites and targets."[61] In other words, hormones and chemical peptides can influence a number of body functions and observable behaviors.

This chapter explores the dynamic between neuro-chemicals and observable behavior. To provide a foundation for understanding for readers unfamiliar with the intricacies of the brain, the first section of this chapter will discuss salient facts about brain structure including pertinent components of the brain and how they interact. This chapter will then focus on specific hormones and peptides that have been shown to influence behavior, including oxytocin, vasopressin, serotonin and adrenaline. The chapter will conclude with analyses of specific studies linking oxytocin with trust-building, bonding, nurturing and empathy.

---

[59] Jon Cohen. "Does Nature Drive Nurture?" *Science* 273, no. 5275 (2 August 1996), 577.

[60] Dorothy T. Krieger. "Brain Peptides: What, Where and Why?" *Science* 222, no. 4627 (2 December 1983), 976.

[61] Ibid., 976.

## A. NEUROANATOMY

Basic understanding of brain structure is a necessary foundation for further arguments in this thesis. This section is by no means intended to be all-inclusive about the structure of the brain. Instead, this discussion will be limited to brain structures relevant to the overall topic of this thesis: oxytocin and trust. Thus, the following neuroanatomical discussion will focus mainly on the hypothalamus, pituitary gland, amygdala, periaqueductal gray, habenula, and septal nuclei.

### 1. Hypothalamus

The hypothalamus is a small gland (about the size of an almond) located just beneath the thalamus ('hypo,' meaning under).[62] Despite its small size, the hypothalamus has profound effects on the human body. The hypothalamus connects the nervous system with the endocrine system (internal organs such as the heart, muscles, skin, reproductive organs and digestive organs), essentially forming the primary pathway for neurochemical signals to regulate body functions.[63] The hypothalamus also regulates the production of several hormones, such as vasopressin and oxytocin among others, which act to control the body's numerous autonomic functions: circadian rhythm, hunger, thirst, body temperature, water retention, blood pressure and heart rate.[64] The hypothalamus is comprised of three distinct regions: the anterior, tuberal and posterior.[65] Each region contains nuclei that perform very distinct functions.

---

[62] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet; *John H. Martin.* Neuroanatomy: Text and Atlas. *NYC: McGraw-Hill, 2003, 260*; Ben Best. "Chapter 7: Brain Areas Supporting Cerebral Cortex Function" [article on-line]. Clinton Township, MI: Cryonics Institute, 2007, accessed 21 October 2007; available from http://www.benbest.com/science/anatmind/anatmd7.html; Internet.

[63] Ibid.

[64] Ibid.

[65] Ibid.

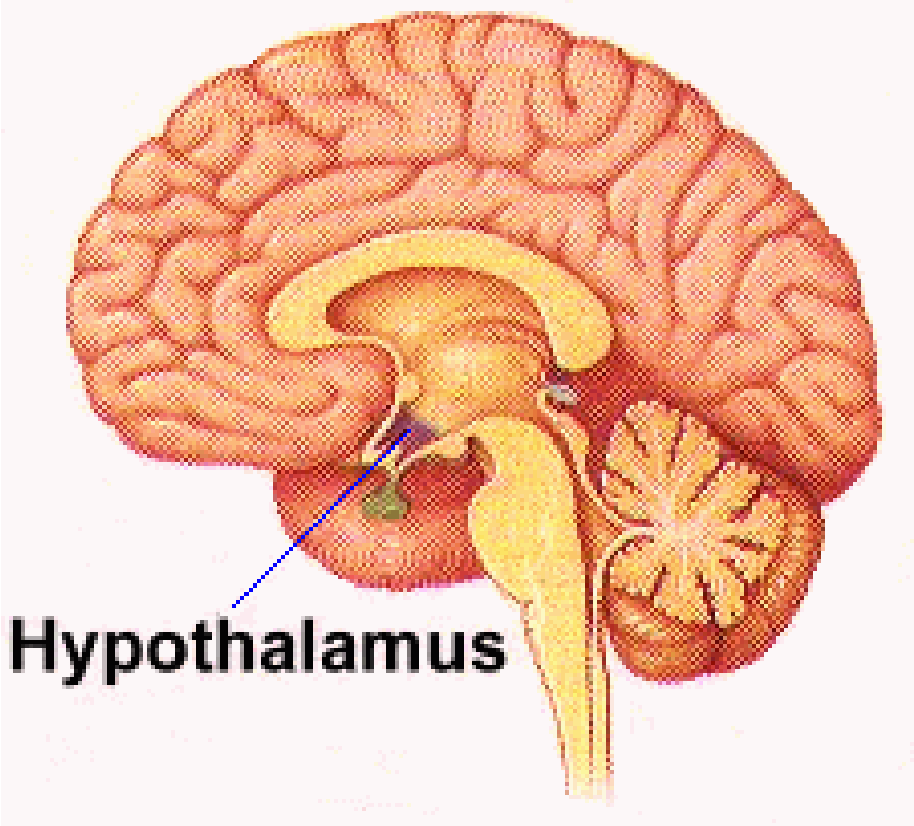


Figure 1. Diagram depicting relative location of the hypothalamus.[66]

The hypothalamus was first associated with regulation of hunger, thirst and satiety;[67] however, the hypothalamus has much wider effects on the human organism. Studies have shown that the hypothalamus contains a region (or regions) that affect self-stimulation or reward responses.[68] The pre-optic area of the hypothalamus plays an influential role in nurturing behavior. Damage to the pre-optic area can inhibit social

[66] David Darling. "Hypothalamus" [article on-line]. NYC: Encyclopedia of Science, 2007, accessed 21 October 2007; available from http://www.daviddarling.info/encyclopedia/H/hypothalamus.html; Internet.

[67] Franklin B. Krasne. "General Disruption Resulting from Electrical Stimulus of Ventromedial Hypothalamus." *Science* 138, no. 3542 (16 November 1962); 822 and Bartley G. Hoebel and Philip Teitelbaum. "Hypothalamic Control of Feeding and Self-Stimulation." *Science* 135, no. 3501 (2 February 1962); 475.

[68] D. L. Margules and J. Olds. "Identical 'Feeding' and 'Rewarding' Systems in the Lateral Hypothalamus of Rats." *Science* 135, no. 3501 (2 February 1962); 376.

interaction and bonding.[69] The hypothalamus also plays a role (perhaps tertiary) in the formation of emotion. This effect was exemplified by a curious case study, "an eighteen-year-old female who ate as much as 10,000 calories a day."[70] Lesions on the subject's hypothalamus produced a condition called hyperphagia or extreme, uncontrollable hunger from which the sufferer is denied the satiety response. Consequently, "she experienced ravenous hunger, and interestingly enough, became very angry when she was hungry. In fact, her violent rage could only be controlled by allowing her to eat to repletion."[71]

Additionally, the hypothalamus influences the escape response (avoidance of threat).[72] Studies have shown that "cortical and hypothalamic impulses are mutually linked to cause inhibition in the amygdala,"[73] where fear responses are processed. Thus, the hypothalamus exerts some influence in the fight or flight response. The hypothalamus is also known to influence functions of the cerebellum,[74] hippocampus, thalamus and pituitary gland.[75]

Given the full range of activities controlled by the hypothalamus, it is certainly an influential brain structure. The hypothalamic functions most relevant to this thesis are production of oxytocin, effects on nurturing behavior and close interaction with the amygdala and pituitary gland.

---

[69] Jon Cohen. "Does Nature Drive Nurture?" *Science* 273, no. 5275 (2 August 1996), 577.

[70] Eliot Stellar. "Brain Mechanisms in Hunger and other Hedonic Experiences." *Proceedings of the American Philosophical Society* 118, no. 3 (7 June 1974); 276.

[71] Ibid., 280.

[72] Franklin B. Krasne. "General Disruption Resulting from Electrical Stimulus of Ventromedial Hypothalamus." *Science* 138, no. 3542 (16 November 1962); 822.

[73] R. Caruthers, A. K. Mueller, H. F. Muller and P. Gloor. "Interaction of Evoked Potentials of Neocortical and Hypothalamic Origin in the Amygdala." *Science* 144, no. 3617 (24 April 1964); 423.

[74] Espen Dietrichs. "Cerebellar Autonomic Function: Direct Hypothalamocerebellar Pathway." *Science* 223, no.4636 (10 February 1984); 593.

[75] Yukari Date, Yoichi Ueta, Hiroshi Yamashita, Hideki Yamaguchi, Shigeru Matsakura, Kenji Kangawa, Takeshi Sakurai, Masashi Yanagisawa and Masamitsu Nakazato. "Orexins, Orexigenic Hypothalamic Peptides, Interact with Autonomic, Neuroendocrine and Neuroregulatory Systems." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 2 (19 January 1999); 753.

## 2. Pituitary Gland

The pituitary gland is a pea-sized organ located just beneath the hypothalamus.[76] Like the hypothalamus, the pituitary gland's small size is deceptive of the enormity of its influence on the human body. The pituitary gland's primary job is regulating homeostasis (maintaining a stable internal environment, necessary for survival).[77] The pituitary gland exerts control over growth, maturation and metabolism.[78] Additionally, the pituitary gland influences proper functioning of the thyroid gland and sex organs.[79]

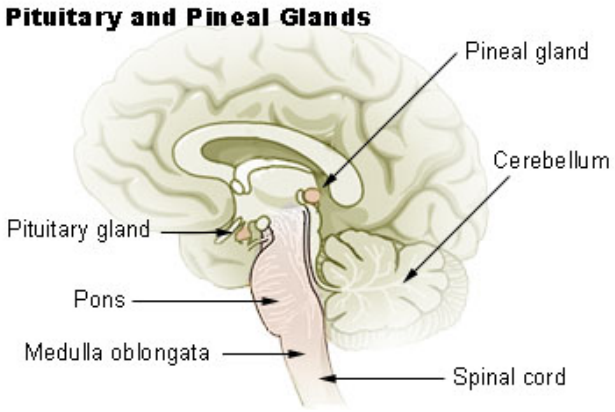


Figure 2. Illustration depicting the relative position of the pituitary gland.[80]

These functions are controlled by regulating the saturation and dispersal of hormones including oxytocin.[81] Oxytocin is received from the hypothalamus in the posterior pituitary, which then secretes oxytocin into the bloodstream.

---

[76] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet.

[77] Ibid.

[78] Ibid.

[79] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet and US National Cancer Institute. "Pituitary Gland" [article on-line]. Atlanta, GA: Emory University, 2007, accessed 21 October 2007; available from http://training.seer.cancer.gov/module_anatomy/unit6_3_endo_glnds1_pituitary.html; Internet.

[80] US National Cancer Institute. "Pituitary Gland" [article on-line]. Atlanta, GA: Emory University, 2007, accessed 21 October 2007; available from http://training.seer.cancer.gov/module_anatomy/unit6_3_endo_glnds1_pituitary.html; Internet.

[81] Michael J. Brownstein, James T. Russell and Harold Gainer. "Synthesis, Transport and Release of Posterior Pituitary Hormones." *Science* 207, no. 4429 (25 January 1980); 377.

### 3. Amygdala

The common term amygdala actually refers to a group of nuclei (collectively referred to as amydalae) located toward the underside of the brain.[82] "The amygdala has up to 22 distinct regions,"[83] which demonstrates the complexity of the amygdala. The amygdala is well-connected to other sections of the brain including the prefrontal cortex, association cortex, orbitifrontal cortex, temporal lobe, olfactory system, hypothalamus, hippocampus and periaqueductal gray.[84]

The amygdala influences emotions,[85] and is most closely associated with the emotion of fear: "the amygdala is specialized for reacting to stimuli and triggering a physiological response, a process that would be described as the emotion of fear."[86] Studies have demonstrated that damaging particular parts of the amygdala eliminate the learned-fear response.[87] Fear is processed in conjunction with the hippocampus (which processes alarm cues) and the prefrontal cortex (which records or memorizes fear).[88] The

---

[82] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet.

[83] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet.

[84] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet; Marcia Barinaga. "How Scary Things Get That Way." *Science* 258, no. 5084 (6 November 1992), 888; Antoine Bechara, Daniel Tranel, Hanna Damasio, Ralph Adolphs, Charles Rockland, Antonio R. Damasio. "Double Dissociation of Conditioning and Declarative Knowledge Relative to the Amygdala and Hippocampus in Humans." *Science* 269, no. 5227 (25 August 1995, 1117; N. Isenberg, D. Silbersweig, A. Engelien, S. Emmerich, K. Malavade, B. Beattie, A. C. Leon and E. Stern. "Linguistic Threat Activates the Human Amygdala." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 18 (31 August 1999), 10458

[85] Harvey Black. "Amygdala's Inner Workings." *The Scientist* 15, no. 19 (1 October 2001), 20

[86] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet; Marcia Barinaga. "How Scary Things Get That Way." *Science* 258, no. 5084 (6 November 1992); 887.

[87] Marcia Barinaga. "How Scary Things Get That Way." *Science* 258, no. 5084 (6 November 1992), 887

[88] Marcia Barinaga. "How Scary Things Get That Way." *Science* 258, no. 5084 (6 November 1992), 888; Antoine Bechara, Daniel Tranel, Hanna Damasio, Ralph Adolphs, Charles Rockland, Antonio R. Damasio. "Double Dissociation of Conditioning and Declarative Knowledge Relative to the Amygdala and Hippocampus in Humans." *Science* 269, no. 5227 (25 August 1995), 1117

amygdala's close tie with the prefrontal cortex allows the amygdala to play a significant role in memory-formation as well.[89] The amygdala's influence in this process is powerful: "the neural connections from the cortex down to the amygdala are less developed than are connections from the amygdala back up to the cortex. Thus, the amygdala exerts greater influence on the cortex than vice versa. Once an emotion has been turned on, it is difficult for the cortex to turn it off."[90]

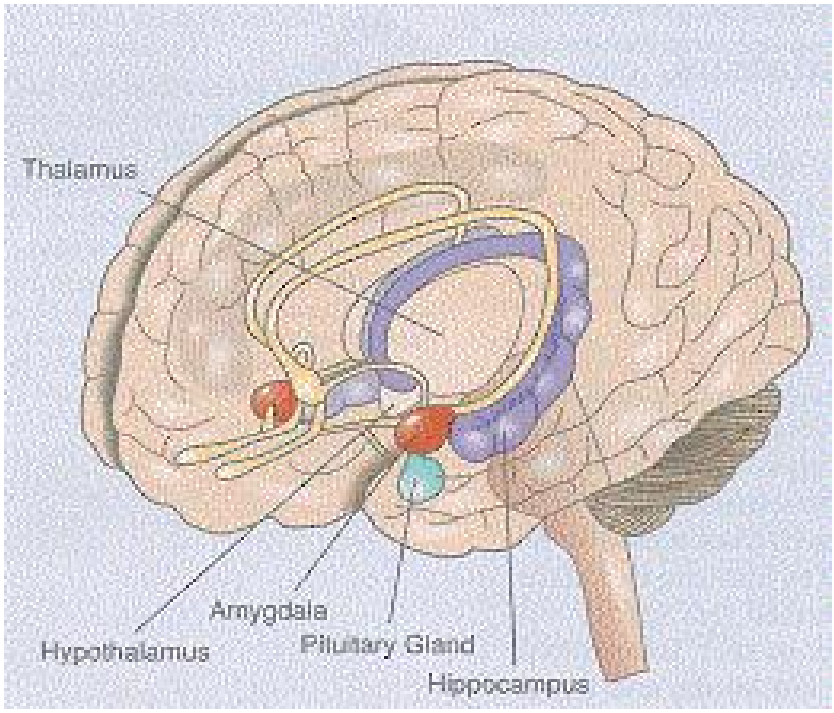


Figure 3. Illustration depicting the relative location of the amygdala.[91]

The amygdala processes a vast array of sensory input very quickly. Olfactory, visual, audial and somatic (touch) inputs all contribute to the amygdala's threat recognition capabilities. Of particular note, studies have demonstrated how acute these threat recognition capabilities can be. For example, independent studies provide

[89] James L. McGaugh, Larry Cahill and Benno Roozendaal. "Involvement of the Amygdala in Memory Storage: Interaction with Other Brain Systems." *Proceedings of the National Academy of Sciences of the United States of America* 93, no. 24 (26 November 1996, 13508.

[90] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet.

[91] Verlegen. "De processen in de hersenen" [article on-line]. The Hague: Verlegen, 2007, accessed 21 October 2007; available from www.ikbenverlegen.nl/afbeeldingen/amygdala.jpg; Internet.

evidence that the amygdala processes complex threat cues such as facial expressions[92] and linguistic overtures.[93] Conversely, the amygdala is also a major contributor to trust decisions. In the absence of threat cues, the amygdala contributes to the formation of trust.[94]

### 4. Periaqueductal Gray

The periaqueductal gray is the organ in the brain that inspired the term "gray matter." This organ is located within the midbrain.[95] There are two primary functions of the periaqueductal gray: perception of pain and defensive behavior.[96] Together with the amygdala, the periaqueductal gray is known to process the emotion of fear;[97] however, the amygdala plays a superior role in this relationship: "another responsibility of the amygdala is the suppression of the periaqueductal gray."[98] While the amygdala plays the

---

[92] N. Isenberg, D. Silbersweig, A. Engelien, S. Emmerich, K. Malavade, B. Beattie, A. C. Leon and E. Stern. "Linguistic Threat Activates the Human Amygdala." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 18 (31 August 1999, 10456; Sprengelmeyer, 2451.

[93] N. Isenberg, D. Silbersweig, A. Engelien, S. Emmerich, K. Malavade, B. Beattie, A. C. Leon and E. Stern. "Linguistic Threat Activates the Human Amygdala." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 18 (31 August 1999), 10457.

[94] Marcia Barinaga. "How Scary Things Get That Way." *Science* 258, no. 5084 (6 November 1992), 887.

[95] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet; *John H. Martin.* Neuroanatomy: Text and Atlas. *NYC: McGraw-Hill, 2003, 370.*

[96] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet; Bandler, Richard J., Jr, and John P. Flynn. "Neural Pathways from Thalamus Associated with Regulation of Aggressive Behavior." *Science* 183, no. 4120 (11 January 1974), 97; Fields, H. L. and Mary M. Heinricher. "Anatomy and Physiology of a Nociceptive Modulatory System." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 308, no. 1136 (19 February 1985), 370; Jeansok K. Kim, and Michael S. Fanselow. "Modality-Specific Retrograde Amnesia of Fear." *Science* 256, no. 5057 (1 May 1992); 675.

[97] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet; Jeansok K. Kim, and Michael S. Fanselow. "Modality-Specific Retrograde Amnesia of Fear." *Science* 256, no. 5057 (1 May 1992, 676

[98] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet.

role in threat perception, the periaqueductal gray stimulates defensive behavior.[99] In other words, after the amygdala perceives a threat a signal is sent to the periaqueductal gray to stimulate action such as sounding distress calls or executing fight, flight or freeze reflexes.[100] Without a signal from the amygdala that a threat is present, the periaqueductal gray fails to stimulate defensive measures. In one experiment, several normal mice were exposed to a typical threat: a cat. The mice, of course, reacted defensively and took action to avoid the cat. The amygdala in these mice was then surgically damaged, and the mice were exposed to the cat again. This disruption in the threat perception process negated defensive measures altogether. In this experiment, it was observed that some mice were so fearless as to approach the cat and even nibble on its ear.[101]

[99] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet.

[100] Doug Holt. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet.

[101] Marcia Barinaga. "How Scary Things Get That Way." *Science* 258, no. 5084 (6 November 1992), 887.

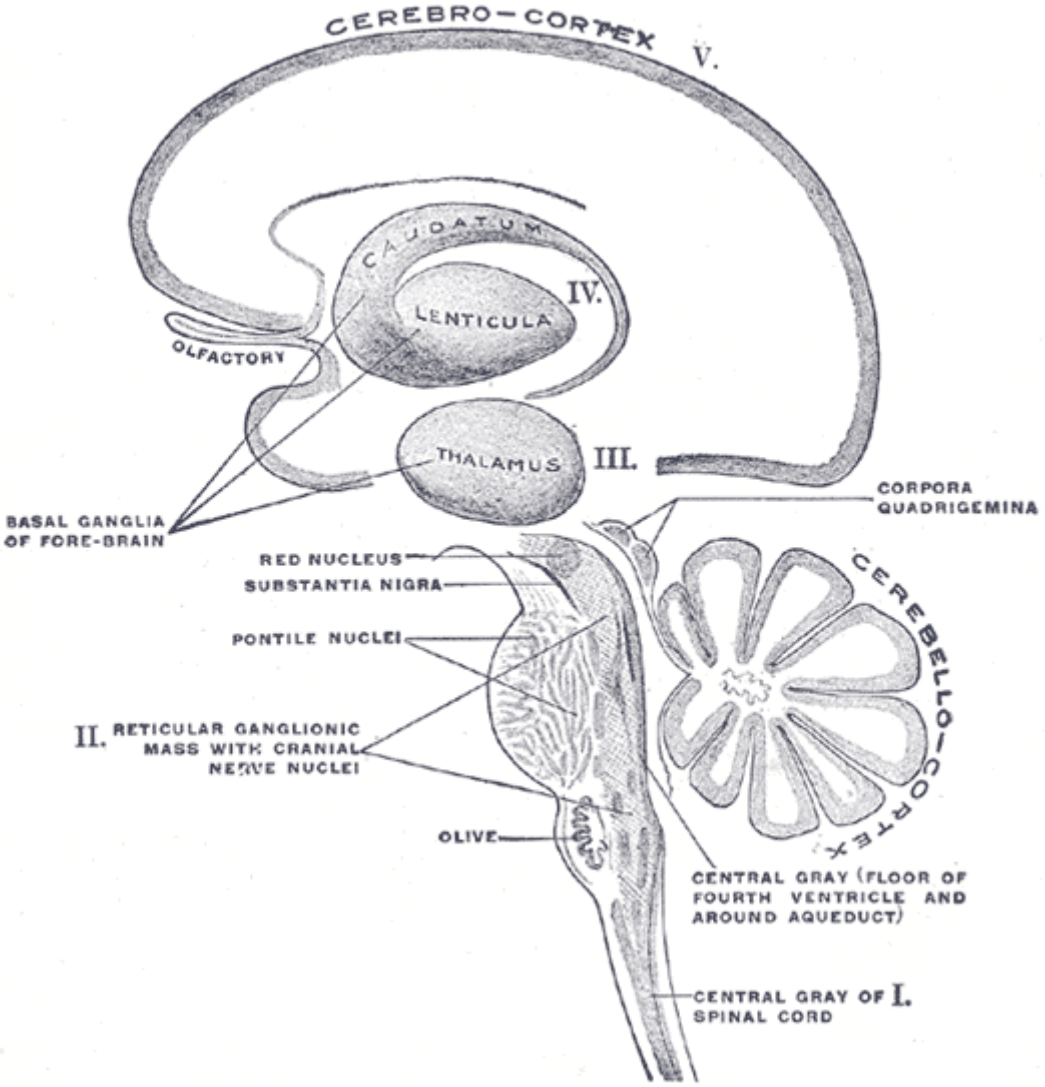


Figure 4. Illustration depicting the relative location of the periaqueductal gray within the brain. In this illustration, the periaqueductal gray is referred to in the lower right hand corner as the central gray, an alternate name for the structure.[102]

[102] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet; John H. Martin. *Neuroanatomy: Text and Atlas.* NYC: McGraw-Hill, 2003, 370.

### 5. Habenula

The habenula is a group of nerve cells embedded in the medullary stria located between the dorsal thalamus and pineal gland.[103] This group of nerve cells acts as a conduit for stimuli that influence the release of mood-regulating and personality-related neurotransmitters and neuromodulators such as dopamine, serotonin and norepinephrine.[104] This primary function makes the habenula a very important link in the feedback loop governing the dispersal of hormones into the bloodstream. Without the habenula, homeostatic functions of the brain would become less effective. Situated between the thalamus and the pineal gland, the habenula is strategically situated to pass chemical messages from the forebrain to the midbrain.[105] The types of neurochemicals transmitted through the habenula influence emotions and behaviors such as aggression, anxiety and pleasure that can significantly influence the trust-building process. These chemicals will be discussed in the following section of this chapter.

---

[103] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet; *John H. Martin.* Neuroanatomy: Text and Atlas. *NYC: McGraw-Hill, 2003, 394.*

[104] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html, Internet; *John H. Martin.* Neuroanatomy: Text and Atlas. *NYC: McGraw-Hill, 2003, 394;* Ben Best. "Chapter 7: Brain Areas Supporting Cerebral Cortex Function" [article on-line]. Clinton Township, MI: Cryonics Institute, 2007, accessed 21 October 2007; available from http://www.benbest.com/science/anatmind/anatmd7.html; Internet

[105] Wang, Rex Y. and George K. Aghajanian. "Physiological Evidence for Habenula as Major Link Between Forebrain and Midbrain Raphe." *Science* 197, no. 4298 (1 July 1977), 91.

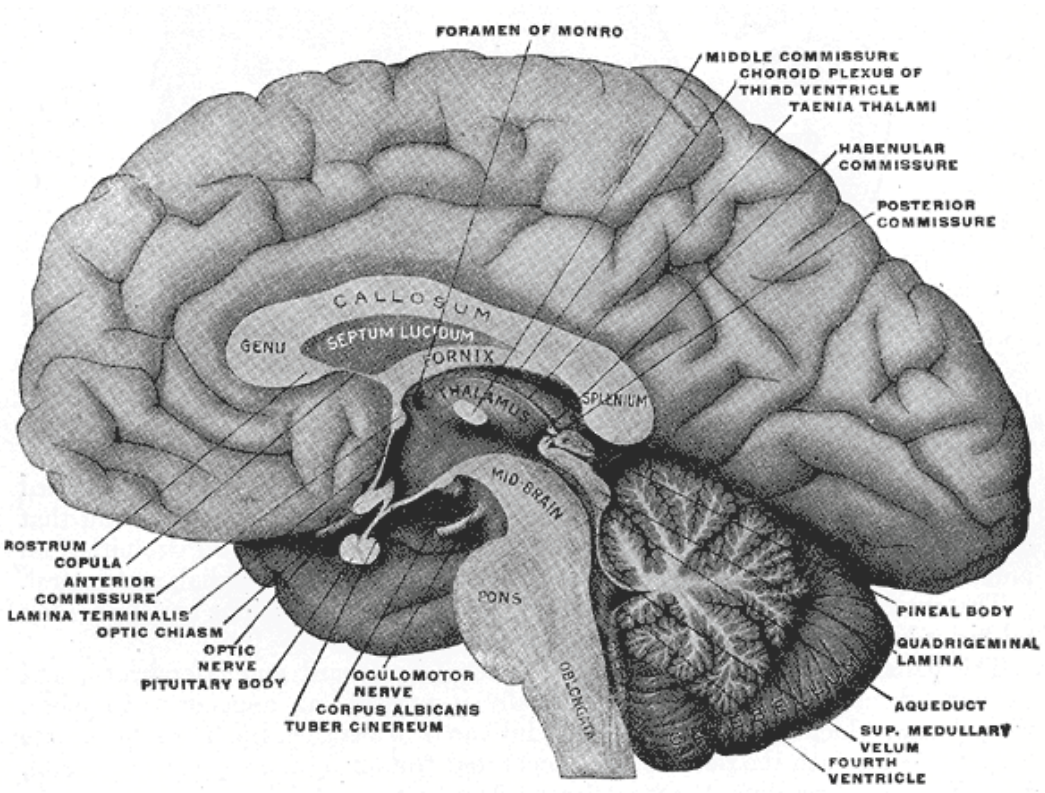


Figure 5. Diagram of brain structures showing the relative position of the habenula (referenced in the upper right-hand corner).[106]

### 6. Septal Nuclei

The septal nuclei are bundles of neurons (separated into medial, lateral, and posterior bundles) located physically in front of the hypothalamus and above the amygdala.[107] The septal nuclei are a major crossroads for neurochemical signals throughout the brain, providing reciprocal pathways to and from many important brain

[106] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet.

[107] John H. Martin. *Neuroanatomy: Text and Atlas.* NYC: McGraw-Hill, 2003, 383-384; Ben Best. "Chapter 7: Brain Areas Supporting Cerebral Cortex Function" [article on-line]. Clinton Township, MI: Cryonics Institute, 2007, accessed 21 October 2007; available from http://www.benbest.com/science/anatmind/anatmd7.html; Internet.

structures such as the hippocampus, amygdala, hypothalamus, midbrain, habenula, cingulate gyrus, and thalamus.[108]

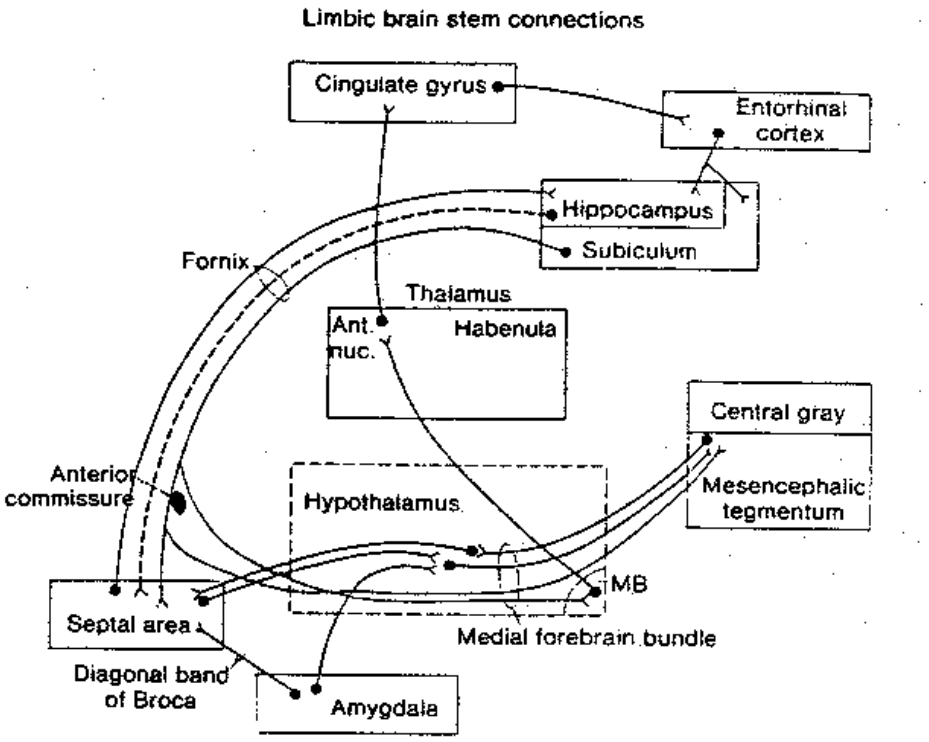


Figure 6. Graphic depiction of neurochemical pathways demonstrating the septal area's centrality.[109]

Additionally, "the septal area is an important pleasure area of the brain, and laboratory animals eagerly press levers that send electrical impulses to this area. Electrical stimulation of the septal area has an inhibitory effect on the autonomic nervous system, including cardiac deceleration."[110] However, damage to the septal nuclei can significantly disrupt normal brain communications and affect exhibited behavior: "Septal lesions produce rage reactions in many species, but these seem to be defensive rather than

[108] Ben Best. "Chapter 7: Brain Areas Supporting Cerebral Cortex Function" [article on-line]. Clinton Township, MI: Cryonics Institute, 2007, accessed 21 October 2007; available from http://www.benbest.com/science/anatmind/anatmd7.html; Internet.

[109] Ibid.

[110] Ibid.

aggressive because the animals try to avoid unfamiliar situations and conflict. Other species become less aggressive following septal lesions."[111] Thus, the role of the septal nuclei as a central communications conduit within the human brain is the most salient characteristic to this thesis.

## B. NEUROCHEMISTRY

As noted in the previous section, the brain synthesizes hormones and regulates hormone levels in the body. Hormones were first identified by medical scientists in the 1920s with the discovery of acetylcholine and epinephrine.[112] In the following decades, scientific studies isolated over a dozen more hormones and characterized their influences over body and brain functions at the most fundamental levels. In fact, hormones act as universal components in all known living things including vertebrates, invertebrates, plants and single-celled organisms.[113] This section reviews five hormones that significantly affect behaviors that either contribute to or degrade the trust-building process: vasopressin, epinephrine and norepinephrine, substance P, serotonin and dopamine. Oxytocin was discussed extensively in Chapter I and will not be reviewed again here.

### 1. Vasopressin

Vasopressin comprises a superfamily of hormones found in several forms across a vast range of species including fish, octopi, mollusks, earthworms, locust, marsupials and mammals.[114] In humans and other mammals, the vasopressin superfamily is expressed in

---

[111] Ben Best. "Chapter 7: Brain Areas Supporting Cerebral Cortex Function" [article on-line]. Clinton Township, MI: Cryonics Institute, 2007, accessed 21 October 2007; available from http://www.benbest.com/science/anatmind/anatmd7.html; Internet.

[112] Dorothy T. Krieger,. "Brain Peptides: What, Where and Why?" *Science* 222, no. 4627 (2 December 1983), 976.

[113] Ibid., 979.

[114] H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.,* ed. R. Lim, 573-607. Springer, New York, 2006, 573.

the form of arginine vasopressin.[115] The primary physiological purpose of vasopressin is regulation of water retention, which indirectly affects kidney functions, bladder control, blood pressure and thirst.[116] Studies have shown that vasopressin hormones perform the same function in other animals. For example, the vasopressin hormone in locusts, called diuretic hormone, also acts to stabilize water stasis.[117]

Vasopressin is structurally similar to oxytocin, differing by only two amino acids.[118] In fact, oxytocin belongs to the vasopressin superfamily. While this difference in amino acids may be perceptually small, the behavioral result of this structural difference is immense. While oxytocin has been shown to engender trust and nurturing behaviors, vasopressin has been shown to elicit aggression.[119] In a physical study of vasopressin within prairie voles, it was noted that artificially introduced vasopressin increased aggression in sexually naïve voles, which normally do not exhibit such behavior.[120] "[Arginine vasopressin] is implicated in the induction of aggression both during development and in adulthood."[121]

---

[115] H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006, 573.

[116] Jack M. George. "Vasopressin and Oxytocin are Depleted from Rat Hypothalamic Nuclei After Oral Hypertonic Saline." *Science* 193, no. 4248 (9 July 1976), 148.

[117] H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006, 576.

[118] Ibid., 576.

[119] John M. Stribley and C. Sue Carter. "Developmental Exposure to Vasopressin Increases Aggression in Adult Prairie Voles." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 22 (26 October, 1999), 12602; C. F. Ferris, H. E. Albers, S. M. Wesolowski, B. D. Goldman and S. E. Luman. "Vasopressin Injected into the Hypothalamus Triggers a Stereotypic Behavior in Golden Hamsters." *Science* 224, no. 4648 (4 May 1984), 521; H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006, 588.

[120] John M. Stribley and C. Sue Carter. "Developmental Exposure to Vasopressin Increases Aggression in Adult Prairie Voles." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 22 (26 October, 1999), 12602.

[121] Ibid., 12602

Vasopressin's social behavioral roles extend beyond aggression. Like oxytocin, vasopressin plays a role in social recognition.[122] Social recognition capabilities become more acute when vasopressin levels are artificially increased.[123] Vasopressin has also been implicated as a significant influence in socio-sexual behavior, providing chemical cues that help to motivate heterosexual, homosexual or asexual behavior.[124]

Finally, vasopressin plays a role in learning and memory. Studies have shown that vasopressin may increase capabilities to retrieve memories, thereby reducing effects of retrograde amnesia. "Not only did [the study] find that vasopressin facilitates memory processing, but that its effects are more robust during consolidation and retrieval rather than during learning."[125] A significant study performed on humans in 1981 demonstrated "statistically significant increases in learning and memory when treated with vasopressin, in contrast to placebo treatment."[126] The study further showed that "retrograde amnesia was substantially reversed after vasopressin treatment,"[127] demonstrating that vasopressin increased the ability of individuals to recall information despite the phenomenon of retrograde amnesia.

### 2. Epinephrine (Adrenaline) and Norepinephrine (Noradrenaline)

Epinephrine is, perhaps, more commonly known as adrenaline. Epinephrine is most closely associated with the fight-or-flight reaction to stress and assists in properly

---

[122] H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006, 590.

[123] Ibid., 590.

[124] S. R. Wersinger, K. R. Kelliher, F. Zufall, S. J. Lolait, A. M. O'Carroll and W. S. Young, III. "Social Motivation Is Reduced in Vasopressin 1b Receptor Null Mice Despite Normal Performance in an Olfactory Discrimination Task." Hormones and Behavior 46, no. 5 (December 2004), 642.

[125] H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006, 593.

[126] Herbert Weingartner, Philip Gold, James C. Ballenger, Sheila A. Smallberg, Richard Summers, David R. Rubinow, Robert M. Post and Frederick K. Goodwin. "Effects of Vasopressin on Human Memory Functions." *Science* 211, no. 4482 (6 February 1981), 602.

[127] Ibid., 603.

reacting to danger or threats.[128] Epinephrine is synthesized by its parent hormone norepinephrine, which also affects the fight-or-flight reaction. From a physiological perspective, epinephrine and norepinephrine act together to enhance glucose production in the liver. Consequently, more fuel is provided to the brain and muscles when the body is under stress or anxiety. Additionally, the body's ability to deliver oxygen to the brain and muscles is also enhanced by epinephrine and norepinephrine. Thus, both hormones are closely linked to the body's ability to cope with stress and anxiety.

Norepinephrine is more influential within the body, acting to control homeostatic functions such as appetite, body temperature, sleep cycles, alertness and motor functions.[129] Norepinephrine has been demonstrated to affect mood as well. Studies indicate that norepinephrine influences depression. When norepinephrine, along with dopamine and serotonin, is depleted in the system, a depressive syndrome occurs.[130] Antidepressant medications usually target norepinephrine reuptake capabilities in order to provide more norepinephrine to the body and disrupt the depressive syndrome.

Norepinephrine also acts to attenuate aggression. Studies have demonstrated that injection of norepinephrine "reduces shock-induced fighting in rats where norepinephrine has been depleted."[131] Thus, norepinephrine can reduce aggressive behavior in addition to attenuating anxiety and depression.

### 3. Substance P

Substance P sounds like an archetypal science-fiction label from a B-movie; however, substance P is actually a powerful neurotransmitter. From a physiological perspective, substance P influences respiratory function, gastrointestinal regulation,

---

[128] Julius Axelrod and Terry D. Reisine. "Stress Hormones: Their Interaction and Regulation." *Science* 224, no. 4648 (4 May 1984), 452-453.

[129] D. E. Redmond, Jr., J. W. Maas, A. Kling, C. W. Graham and H. Dekirmenjian. "Social Behavior of Monkeys Selectively Depleted of Monoamines." *Science* 174, no. 4007 (22 October 1971), 428.

[130] Ibid., 430.

[131] Seymour M. Antelman and Anthony R. Caggiula. "Norepinephrine-Dopamine Interactions and Behavior." *Science* 195, no. 4279 (18 February 1979):, 648.

vomiting[132] and pain perception. Substance P may, in fact, be essential to pain perception. Animals that lack substance P such as naked mole rats are immune to many pain stimuli.[133] However, substance P is also a common and powerful neurotransmitter affecting anxiety, stress and mood disorders.[134] Substance P receptors are "highly expressed in the amygdala, critical for the processing of emotions including fear and anxiety."[135] Studies have demonstrated that substance P negatively correlates with anxiety-behavior. "Mice with selective deletion of the gene encoding the substance P receptor or the peptide itself showed decreased anxiety-related behavior."[136] Substance P is a chemical coping mechanism to anxiety: "emotional stress triggers the release of substance P in the medial amygdala"[137] where substance P then facilitates coping responses to introduced stress.

#### 4. Serotonin

Serotonin is an influential regulatory hormone. Serotonin provides several homeostatic functions such as regulating body temperature, sleep, appetite and vomiting.[138] Additionally, serotonin is a powerful mood regulator, known to

---

[132] D. Stark, S. van Hal, D. Marriott, J. Ellis and J. Harkness. "Irritable bowel syndrome: a review on the role of intestinal protozoa and the importance of their detection and diagnosis". *International Journal of Parasitology* 37, no. 1 (January 2007), 20.

[133] T. J. Park, C. Comer, A. Carol, Y. Lu, H. S. Hong and F. L. Rice. "Somatosensory organization and behavior in naked mole-rats: II. Peripheral structures, innervation, and selective lack of neuropeptides associated with thermoregulation and pain". *Journal of Comprehensive Neurology* 465, no. 1 (January 2003), 119.

[134] Karl Ebner, Nadia M. Rupniak, Alois Saria, Nicolas Singewald and Tomas Hoekfelt. "Substance P in the Medial Amygdala: Emotional Stress-Sensitive Release and Modulation of Anxiety-Related Behavior in Rats." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 12 (23 March 2004), 4280.

[135] Ibid., 4280.

[136] Ibid., 4280.

[137] Karl Ebner, Nadia M. Rupniak, Alois Saria, Nicolas Singewald and Tomas Hoekfelt. "Substance P in the Medial Amygdala: Emotional Stress-Sensitive Release and Modulation of Anxiety-Related Behavior in Rats." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 12 (23 March 2004), 4284.

[138] P. Schloss and D. C. Williams. "The Serotonin Transporter: A Primary Target for Antidepressant Drugs." *Journal of Psychopharmacology* 12, no. 2 (February 1998), 115; D. E. Redmond, , Jr., J. W. Maas, A. Kling, C. W. Graham and H. Dekirmenjian. "Social Behavior of Monkeys Selectively Depleted of Monoamines." *Science* 174, no. 4007 (22 October 1971), 428.

significantly affect anger, aggression, depression and anxiety.[139] Studies have shown that serotonin plays an important role inhibiting negative emotions. For example, many anti-depressant medications such a Prozac encourage serotonin reuptake, thereby minimizing the effects of depressive mood disorders.

A 1994 study demonstrated that mice lacking a certain serotonin receptor exhibited enhanced aggressive behaviors.[140] These results were confirmed by an independent study on serotonin levels in mice completed the following year.[141] A similar study observing the effects of serotonin on fighting behavior among crustaceans was completed in 1997. The 1997 study demonstrated that individuals with high ambient serotonin levels were more aggressive and engaged their opponent longer. Conversely, individuals injected with Prozac were more likely to avoid conflict and demonstrate submissive behavior.[142] Thus, the effect on aggression is influenced by the nervous system's ability to soak up ambient serotonin.

### 5. Dopamine

Dopamine is a hormone with broad capabilities. Dopamine is dispersed by the hypothalamus and used by various parts of the nervous system. In the pituitary gland,

---

[139] Frederic Saudou, Djamel Amara, Andree Dierich, Marianne LeMeur, Sylvie Ramboz, Louis Segu, Marie-Christine Buhot and Rene Hen. "Enhanced Aggressive Behavior in Mice Lacking 5-HT 1B Receptor." *Science* 265, no. 5180 (23 September 1994):, 1878; Robert Huber, Kalim Smith, Antonia Delago, Karin Isaksson and Edward A. Kravitz. "Serotonin and Aggressive Motivation in Crustaceans: Altering the Decision to Retreat." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 11 (27 May 1997),, 5940; Olivier Cases, Isabelle Seif, Joseph Grimsby, Patricia Gaspar, Kevin Chen, Sandrine Pournin, Ulrike Mueller, Michel Aguet, Charles Babinet, Jean Chen Shih and Edward De Maeyer. "Aggressive Behavior and Altered Amounts of Brain Serotonin and Norepinephrine in Mice Lacking MAOA." *Science* 268, no. 5218 (23 June 1995), 1766

[140] Frederic Saudou, Djamel Amara, Andree Dierich, Marianne LeMeur, Sylvie Ramboz, Louis Segu, Marie-Christine Buhot and Rene Hen. "Enhanced Aggressive Behavior in Mice Lacking 5-HT 1B Receptor." *Science* 265, no. 5180 (23 September 1994):, 1878

[141] Olivier Cases, Isabelle Seif, Joseph Grimsby, Patricia Gaspar, Kevin Chen, Sandrine Pournin, Ulrike Mueller, Michel Aguet, Charles Babinet, Jean Chen Shih and Edward De Maeyer. "Aggressive Behavior and Altered Amounts of Brain Serotonin and Norepinephrine in Mice Lacking MAOA." *Science* 268, no. 5218 (23 June 1995), 1766.

[142] Robert Huber, Kalim Smith, Antonia Delago, Karin Isaksson and Edward A. Kravitz. "Serotonin and Aggressive Motivation in Crustaceans: Altering the Decision to Retreat." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 11 (27 May 1997), 5942.

dopamine acts to inhibit the release of prolactin.[143] Dopamine also helps to control heart rate and blood pressure. Increased dopamine levels increase heart rate and blood pressure.[144] In other areas of the brain, dopamine acts to regulate alertness and the sleep cycle. Parkinson's disease, which impairs motor skills and speech capability, is associated with a lack of dopamine in the basal ganglia area of the brain.[145] Thus, dopamine seems to be a necessary neurotransmitter for effective communications within the central nervous system.

Dopamine plays a profound role in the perception of pleasure. Several illicit drugs such as amphetamines and mescaline are similar in structure to dopamine and act to stimulate the pleasure centers of the brain in a similar manner as dopamine.[146] The correlation between dopamine and perception of pleasure has linked this hormone with addiction—drugs that excite dopamine reuptake tend to be more addictive.[147] Dopamine's ability to stimulate the pleasure response has inspired research into use as an anti-psychotic medication.[148] Dopamine's anti-psychotic capabilities are most likely linked to its utilization within the periaqueductal gray, which determines defensive responses to threat stimuli.[149] Therefore, dopamine plays a role in aggression and defensive responses. Dopamine may alleviate psychotic behavior by attenuating the defensive response emanating from an overactive periaqueductal gray in patients suffering from psychotic disorders.[150]

---

[143] John R. Walker and George F. Koob. "Orphan Anxiety." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 26 (23 December 1997), 14217.

[144] Ibid., 14218.

[145] Leslie L. Iverson., "Dopamine Receptors in the Brain." *Science* 188, no. 4193 (13 June 1975), 1088

[146] Jack D. Barchas, Huda Akil, Glen R. Elliot, R. Bruce Holman and Stanley J. Watson. "Behavioral Neurochemistry: Neuroregulators and Behavioral States." Science 200, no. 4344 (26 May 1978), 969.

[147] Harvey Black. "Amygdala's Inner Workings." *The Scientist* 15, no. 19 (1 October 2001), 17113.

[148] Leslie L. Iverson., "Dopamine Receptors in the Brain." *Science* 188, no. 4193 (13 June 1975), 1089; Jack D. Barchas, Huda Akil, Glen R. Elliot, R. Bruce Holman and Stanley J. Watson. "Behavioral Neurochemistry: Neuroregulators and Behavioral States." Science 200, no. 4344 (26 May 1978), 969.

[149] Jack D. Barchas, Huda Akil, Glen R. Elliot, R. Bruce Holman and Stanley J. Watson. "Behavioral Neurochemistry: Neuroregulators and Behavioral States." Science 200, no. 4344 (26 May 1978), 968.

[150] Leslie L. Iverson., "Dopamine Receptors in the Brain." *Science* 188, no. 4193 (13 June 1975), 1087; Jack D. Barchas, Huda Akil, Glen R. Elliot, R. Bruce Holman and Stanley J. Watson. "Behavioral Neurochemistry: Neuroregulators and Behavioral States." Science 200, no. 4344 (26 May 1978), 968.

## C. INTERCONNECTION BETWEEN NEUROANATOMY AND NEUROCHEMISTRY

The interconnection between brain structure and hormones is a complex relationship. While damage or complete elimination of a certain brain structure or the depletion of a certain hormone has been shown to affect functions and behavior, there are several other factors that determine the end result of neurochemical and neuroanatomical interactions. Behavioral outcomes can also be altered by size differentials in brain structure, number of receptor sites, distribution of receptor sites and presence of antagonists.

When it comes to brain structures, size does matter. Notable differences in behavior can occur due to increased or decreased size of an individual's brain component in relation to the size of another individual's brain component. For example, studies have demonstrated that male sexual orientation correlates to the size of the suprachiasmatic nucleus. The suprachiasmatic nucleus in a homosexual male brain is "is 1.7 times as large as that of a reference group of male subjects and contains 2.1 times as many cells."[151]

The number of receptor sites for a particular hormone can also influence behavior. A larger number of receptor sites means the brain can soak up more of a particular hormone than a brain with less receptor sites. Studies have linked the number of receptor sites (and corresponding increased or decreased ability to use available hormones) to alterations in observable behavior. For example, a separate study on homosexuality "found more than twice as many vasopressin neurons in the suprachiasmatic nucleus of homosexual men as compared to heterosexual men."[152] Likewise, the distribution of receptor sites also can affect behavior.

Hormone reuptake can also be affected by the presence of antagonists, which can inhibit reuptake of the hormone by binding to that hormone's receptor site or inhibit reuptake by acting to break down the hormone. For example, bicuculline is a known

---

[151] D. F. Swaab and M. A. Hofman. "An Enlarged Suprachiasmatic Nucleus in Homosexual Men." *Brain Research* 537, no. 1-2 (24 December 1990), 141.

[152] J. N. Zhou, M. A. Hofman and D. F. Swaab. "No changes in the number of vasoactive intestinal polypeptide (VIP)-expressing neurons in the suprachiasmatic nucleus of homosexual men; comparison with vasopressin-expressing neurons." *Brain Research* 672, no. 1-2 (20 February 1995), 285.

antagonist for the hormone gamma-aminobutyric acid.[153] The presence of bicuculline antagonists in the system deteriorates the effects of the gamma-aminobutyric acid hormone.

These additional factors are important considerations in any effort to understand the effects of a certain hormone on behavior. Studies on oxytocin demonstrate that these factors also affect the ability of oxytocin to affect behavior. For example, the distribution of oxytocin receptor sites appears to affect social expression: "just as maternal and reproductive behaviors may be mediated by separate oxytocin receptor fields in the rat brain, results with pine and meadow voles suggest that oxytocin receptors in the septum may be associated with social organization (monogamy vs. polygamy), whereas oxytoxin receptors in the amygdala may be important for parental behavior."[154] Additionally, several oxytocin antagonists exist: barusiban, FE 200 440 and atosiban;[155] however, it should be noted that these antagonists have been studied for their effects on childbirth rather than their effects on trust or trust-building.

## D. NEUROLOGICAL STUDIES

Until recently, medical science has had a relatively superficial knowledge about structure of the brain and the functions of hormones; however, recent neurological discoveries have uncovered radical new perspectives on the true complexity of the brain and the degree of influence that hormones exert over the human organism. This section examines neurological discoveries that have broadened understanding of how trust, perception and hormones are created and processed by the brain.

---

[153] Stephen R. Zukin, Anne B. Young and Solomon H. Snyder. "Gamma-Aminobutyric Acid Binding to Receptor Sites in the Rat Central Nervous System." *Proceedings of the National Academy of Sciences of the United States of America* 71, no. 12 (16 December 1974), 4802.

[154] Thomas R. Insel and Lawrence E. Shapiro. "Oxytocin Receptor Distribution Reflects Social Organization in Monogamous and Polygamous Voles." *Proceedings of the National Academy of Sciences of the United States of America* 89, no. 13 (1 July 1992), 5985.

[155] L. Nilsson, T. Reinheimer, M. Steinwall and M. Akerlund. "FE 200 440: a selective oxytocin antagonist on the term-pregnant human uterus." *BJOG* 110, no. 11 (November 2003), 1025; Torsten M. Reinheimer, Walter H. Bee, John C. Resendez, Julie K. Meyer, George J. Haluska and Garry J. Chellman. "Barusiban, A New Highly Potent and Long Acting Oxytocin Antagonist: Pharmacokinetic and Pharmacodynamic Comparison to Atosiban in a Cynomolgus Monkey Model of Preterm Labor." *The Journal of Clinical Endocrinology and Metabolism* 1210, no. 10 (25 January 2005), 2004.

### 1. Trust and Brain Function

Significant data demonstrates that the brain works differently when people trust than when they do not. Subjects in two independent trust experiments underwent magnetic resonance imaging (MRI) scans while making trust decisions. MRI scans showed that certain areas of the brain activate when a person decides to trust, specifically the prefrontal cortex and caudate nucleus.[156] Conversely, these areas did not activate in brains of individuals who decide not to trust. Interestingly, the object of your trust also affects how your brain operates. MRI scans demonstrate that different areas of the brain activate when an individual is deciding to put trust in another person or deciding to put trust in a computer,[157] which seems to indicate that there truly are different forms of trust perceived by the brain. Furthermore, oxytocin levels have been strongly linked to the operation of the prefrontal cortex and caudate nucleus, and increased oxytocin levels positively correlate with increased trust.[158]

### 2. Oxytocin and Sociability

In Chapter I, studies on oxytocin were shown to increase trust and enhance trust-building; however, oxytocin provides several secondary behavioral benefits. Several studies indicate that oxytocin increases an individual's sociability and readiness to engage in social situations. For example, oxytocin reduces the effects of social deficit disorders such as schizophrenia.[159] Drug abuse-related social deficits are also alleviated by oxytocin: "A bilateral infusion of 1 mug of oxytocin into the central amygdala

---

[156] Brain Injury Resource Foundation. "Scan Shows if People Trust You." [article on-line]. Atlanta, GA: Brain Injury Resource Foundation, 2007, accessed 27 October 2007; available from http://www.birf.info/home/whats-new/international/trust-scan.html; Internet; *Kevin A. McCabe.* "A Cognitive Theory of Reciprocal Exchange." In *Trust and Reciprocity*, ed. Elinor Ostrom and James Walker, 147-167. NYC: Russell Sage Foundation, 2003, 166.

[157] Kevin A. McCabe. "A Cognitive Theory of Reciprocal Exchange." In *Trust and Reciprocity*, ed. Elinor Ostrom and James Walker, 147-167. NYC: Russell Sage Foundation, 2003, 166.

[158] Lim Xuan-shi. "A Closer Look at the Familiar: What Do We Know About Trust?" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 27 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro05/web3/xlim.html; Internet.

[159] P. R. Lee, D. L. Brady, R. A. Shapiro, D. M. Dorsa and J. I. Koenig. "Social interaction deficits caused by chronic phencyclidine administration are reversed by oxytocin." *Neuropsychopharmacology* 30, no. 10 (October 2005), 1883.

selectively restored the normal quantity and quality of social behavior in chronic PCP-treated male rats without altering open field behaviors."[160] The sociability benefits of oxytocin may be useful in law enforcement and military scenarios as well, reducing reluctance to engage with law enforcement and military officials in certain scenarios.

Additionally, oxytocin improves teamwork. In a University of North Carolina study, oxytocin was demonstrated to positively influence the magnitude of support given to one's partners: "greater partner support is linked to higher oxytocin for both men and women."[161] Once a partnership is formed, oxytocin helps to strengthen dedication to that partnership.

### 3. Oxytocin and Empathy

Empathy is "the ability to infer the internal state of another person to adapt one's own behavior…a cornerstone of all human social interactions."[162] Empathy is necessary "to make sense of or predict another person's behavior,"[163] and oxytocin increases one's ability to read social cues and make predictions about behavior. Independent studies demonstrated that oxytocin significantly increased a test subject's ability to read social cues. "A single dose of intra-nasally administered oxytocin is sufficient to cause a substantial increase in the ability in affective mind-reading and therefore in interpreting subtle social cues from the eye region of other individuals."[164] A separate study completed at the Mount Sinai School of Medicine demonstrated that oxytocin facilitates

---

[160] P. R. Lee, D. L. Brady, R. A. Shapiro, D. M. Dorsa and J. I. Koenig. "Social interaction deficits caused by chronic phencyclidine administration are reversed by oxytocin." *Neuropsychopharmacology* 30, no. 10 (October 2005), 1893.

[161] Karen M. Grewen, Susan S. Girdler, Janet Amico and Kathleen C. Light. "Effects of Partner Support on Resting Oxytocin, Cortisol, Norepinephrine, and Blood Pressure Before and After Warm Partner Contact." *Psychosomatic Medicine* 67 (October 2005), 538.

[162] Gregor Domes, Markus Heinrichs, Andre Michel, Christoph Berger and Sabine C. Herpertz. "Oxytocin Improves Mind-Reading in Humans." *Biological Psychiatry* 10, no. 1016 (15 July 2006), 731.

[163] Ibid., 731.

[164] Ibid., 732.

understanding of social cues "through both hearing and vision,"[165] revealing that oxytocin is effective across multiple interpretive venues and affects a wide spectrum of perceptive capabilities. This research has been influential in potential treatment for severe disorders such as Parkinson's disease, Asperger's disease and autism.

### 4. Oxytocin and Autism

"Autism patients are often unable to detect or read emotion in others through facial and voice cues, resulting in the decreased ability to have meaningful interactions with others."[166] Experiments demonstrate that oxytocin relieves several dysfunctional symptoms of autism including "need to tell/ask, touching and repeating."[167]

Memory problems also afflict autistic individuals. New evidence suggests that this difficulty may be related to the ability to process social data: "Patients with frontal lesions may show deficits on temporal order memory tasks because memory for temporal order requires the subject to retain more than the content of the memory….the results on memory dysfunction in autism are equivocal."[168] While no studies directly link oxytocin with improved memory in autistic individuals, the potential as a treatment exists given the data that supports oxytocin's ability to improve the ability to process social data.

## E. CONCLUSION

This chapter is an attempt at encapsulating a very complex subject: the inner workings of the nervous system. It was intended to provide a summary study of brain components, hormones and neurological studies specifically related to trust formation. The underlying purpose of this discussion was to demonstrate a definitive correlation

---

[165] Jennifer A. Bartz, and Eric Hollander. "Is Oxytocin the Key to Understanding?" [article on-line]. NYC: Scientific American, 2007, accessed 27 October 2007; available from http://blog.sciam.com/index.php?title=the_hormone_that_helps_you_read_minds&more=1&c=1&tb=1&pb=1; Internet, 538.

[166] E Hollander, J. Bartz and W. Chaplin. "Oxytocin increases retention of social cognition in autism". *Biological Psychiatry* 61, no. 4 (2007), 503.

[167] Ibid., 503.

[168] Loisa Bennetto, Bruce F. Pennington and Sally J. Rogers. "Intact and Impaired Memory Functions in Autism." *Child Development* 67, no. 4 (August 1996), 1817.

between physiology and trust—that one's biology affects the trust-building process. To that end, significant data linking brain functions and oxytocin with effective trust-building was presented. A positive correlation between oxytocin levels and trust-building has been demonstrated by numerous studies. Therefore, it seems plausible to expect that artificially increasing oxytocin levels will enhance the trust-building process. The next chapter will discuss emotions and behaviors that act to degrade trust. The emphasis will shift from physiology and neurochemistry to observed behaviors.

# III. THE ANTITHESIS OF TRUST

While the preceding chapter focused on physiological influences on behavior, this chapter shifts focus to emotions and observable behavior. More specifically, this chapter examines factors that influence trust and trust-building, either positively or negatively. These factors are relevant to the overall thesis discussion because one or more may be present in the law enforcement and military scenarios where potential applications for oxytocin could be most useful. The factors examined in this chapter include distrust, fear, anxiety, aggression and pathologies (such as paranoia and impulsive aggressive disorder).

## A. DISTRUST

"Strong trust as well as strong distrust may occur at the same time between the same actors."[169] The simultaneous occurrence of trust and distrust during a social transaction may seem to be a paradox, yet it seems to occur on a frequent basis. "Trust and distrust are functional equivalents in that both reduce uncertainty."[170] In law enforcement and military scenarios, the simultaneous occurrence of trust and distrust could be even more prevalent, given the inherent antagonistic nature of many scenarios.

Given its negative connotations, "distrust is not necessarily bad or destructive."[171] Elements of distrust signal cautionary or protective measures which help individuals to avoid potential harm. All social relationships carry both a degree of trust and a degree of distrust. No social relationship is black (purely trustful) or white (purely distrustful), but instead a shade of gray. Within a social relationship, "trust can be domain specific. For

[169] Vincent Buskens and Werner Raub. "Embedded Trust: Control and Learning." In *Group Cohesion, Trust and Solidarity*, ed. Shane R. Thye and Edward J. Lawler, 167-202. Oxford, UK: Elsevier Science Ltd, 2002, 183.

[170] Niklas Luhmann. "Familiarity, Confidence, Trust: Problems and Alternatives." In *Trust: Making and Breaking Cooperative Relationships*, ed. Diego Gambetta, 94-107. Oxford: Basil Blackwell, 1988, 166.

[171] Karen S. Cook, Russell Hardin and Margaret Levi. *Cooperation Without Trust?* NYC: Russell Sage Foundation, 2005, 60.

example, I trust you to do X, but I don't trust you to do Y,"[172] which again exemplifies the fact that trust and distrust commonly exist simultaneously in social relationships. The ratio of trust and distrust in a social relationship is also mutable over time: "boundaries between trust and distrust define personal relationships and explain their development through certain kinds of crisis."[173] Even in well-formed social relationships, members may continuously evaluate the trustworthiness of other members based on evolving experiences and social cues. The ratio of trust and distrust constantly evolves based on positive and negative interactions.

Throughout the span of the social relationship, whether it is minutes or decades, "distrust protects one against losses that would follow from taking the risk of cooperating with others. But it can wreck one's own opportunities in a society or context in which others are generally trustworthy."[174] Thus, the ability to read social cues and make accurate trust assessments is vital to every individual.

"The central problem of distrust in any social relationship is a conflict of interest."[175] This means that when stakes are high or resources are scarce, the level of distrust in social interactions may be heightened. This point is especially salient to law enforcement and military personnel when engaged in time-sensitive, dangerous or hostile situations where rapid trust-building is critical. The goal in these situations is to emphasize the trust aspect over the distrust aspect, and the studies presented in both previous chapters demonstrate that artificially-heightened levels of oxytocin certainly work toward this goal.

## B. FEAR

Fear is an intense emotion. Many recent studies have indicated that "stimuli that convey emotion command privileged status in the brain and enjoy enhanced processing in

---

[172] Dorothy Denning, Naval Postgraduate School instructor, interview by author, 14 November 2007, in person.

[173] Karen S. Cook, Russell Hardin and Margaret Levi. *Cooperation Without Trust?* NYC: Russell Sage Foundation, 2005, 66.

[174] Russell Hardin. *Trust and Trustworthiness*. NYC: Russell Sage Foundation, 2002, 96.

[175] Karen S. Cook, Russell Hardin and Margaret Levi. *Cooperation Without Trust?* NYC: Russell Sage Foundation, 2005, 60.

a distributed network of brain regions that react to such stimuli and develop reactive responses to such stimuli."[176] Many biological and physiological studies contend that emotions evolved as strong chemical motivators toward effectively reacting within a hostile natural environment and that the psychological meanings attached to emotions are artificial by-products of the natural chemical phenomenon.[177] Like trust, emotions such as fear can be broken down into cognitive and non-cognitive aspects.[178] The cognitive aspect of fear relates to the emotional state and cultural meanings ascribed to fear. Additionally, humans can cognitively conjure fear through memory or imagination, which are cognitive processes. Conversely, the non-cognitive aspect of fear relates to the autonomic electro-chemical stimulation of brain structures such as the amygdala and periaquductal gray. However, it is significant to note that the cognitive and non-cognitive aspects of fear are intrinsically linked. For example, a base fear response may be ignited by an electro-chemical response in the amygdala. This fear response may become encoded and stored as emotional associative learning in the forebrain in reference to tone and contextual fear assessments stored in the cerebellum.[179] The stored fear response stored as memory in the forebrain may be cognitively invoked at a later time, eliciting a similarly fearful response as the original incident.[180]

Regardless of its core source, fear is perceived to be undeniably real when experienced by an individual. Additionally, in situations where levels of fear are high, the need for balancing measures to counter the psychological effects (and resulting behaviors) of fear is equally high. Since fear and trust assessments are processed by the same structure within the brain (the amygdala), the two psychological concepts are closely related. In fact, studies have shown that fear and trust influence each other. Interestingly, the presence of fear tends to increase the likelihood of elicited trust

---

[176] Richard J. Davidson, Jeffrey S. Maxwell and Alexander J. Shackman. "The Privileged Status of Emotion in the Brain." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 33 (17 August 2004), 11915.

[177] Mohan Matthen. "Biological Universals and the Nature of Fear." *The Journal of Philosophy* 95, no. 3 (March 1988), 105.

[178] Ibid., 109-110

[179] Almira Vazdarjanova. "Chasing 'Fear Memories' to the Cerebellum." *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 12 (11 June 2002), 7814.

[180] Ibid., 7814.

behaviors at least with some individuals. For example, a 1995 experiment demonstrated that "when fear was absent, high and low trusters cooperated at the same level; however, when fear was present, high trusters cooperated more frequently than low trusters."[181] Consequently, fear and trust seem to have a correlative relationship when the desired outcome is cooperation.

Studies have demonstrated that oxytocin can enhance the positive effects of the fear-trust correlation. Oxytocin produces strong physiological responses within the amygdala.[182] As a result of intra-nasally introduced oxytocin, individuals have been observed as "more willing to engage in social situations."[183] It has been posited that oxytocin produces these effects by reducing insular responses to social fear which aids the trust-building process and enhances cooperation.[184]

## C. ANXIETY

In psychological contexts, anxiety is a broad term referring both to an emotional state and a set of behavioral patterns. Anxiety has been described as both "a psychic condition of heightened sensitivity to some perceived threat"[185] and as "a reaction."[186] Oddly enough, these references to anxiety as both an emotional state and as resultant behavior came from the same essay—thus demonstrating how closely the term is linked to both definitional perceptions.

---

[181] Craig D. Parks and Lorne G. Hulbert. "High and Low Trusters' Responses to Fear in a Payoff Matrix." *The Journal of Conflict Resolution* 39, no. 4 (December 1995), 718

[182] Thomas R. Insel and Lawrence E. Shapiro. "Oxytocin Receptor Distribution Reflects Social Organization in Monogamous and Polygamous Voles." *Proceedings of the National Academy of Sciences of the United States of America* 89, no. 13 (1 July 1992), 5981; P. Kirsch, C. Esslinger, Q. Chen, D. Mier, S. Lis, S. Siddhanti, H. Gruppe, V. S. Mattay, B. Gallhoffer and A. Meyer-Lindenberg. "Oxytocin Modulates Neural Circuitry for Social Cognition and Fear in Humans." *Journal of Neuroscience* 25 (December 2005), 11492.

[183] M. Heinrichs, T. Baumgartner, C. Kirschbaum, and U. Ehlert. "Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress." *Biological Psychiatry*, 54 (July 2003): 1389.

[184] Thomas R. Insel and Lawrence E. Shapiro. "Oxytocin Receptor Distribution Reflects Social Organization in Monogamous and Polygamous Voles." *Proceedings of the National Academy of Sciences of the United States of America* 89, no. 13 (1 July 1992), 5984.

[185] Alan Hunt. "Anxiety and Social Explanation: Some Anxieties about Anxiety." *Journal of Social History* 32, no. 3 (Spring 1999), 509.

[186] Ibid., 514.

Though anxiety has been closely linked with fear,[187] anxiety is physiologically much more complex than fear: "a state of fear is elicited by a very specific stimulus….With anxiety, however, it is often difficult to specify the actual sensory event that triggers anxiety."[188] Instead, anxiety has been linked to several physiological influences from substance P levels[189] to serotonin reuptake[190] to changes in plasma free fatty acids.[191] Yet, anxiety is similar to fear in the context of their positive correlative relationships with trust-building and cooperation. Like fear, heightened anxiety levels can positively influence trusting behaviors. For example, in a 2002 experiment, researchers linked anxiety (referred to as distress in the article) to "physiological systems controlling attachment behavior" such as bonding, trust, reciprocity and cooperation.[192] This study demonstrated a positive link between anxiety, attachment behaviors and biology: "distress itself fuels attachment and attachment causes upward fluctuations in opioids."[193] (Opioids are neuro-chemicals that stimulate the pleasure centers of the brain.) In effect, higher anxiety levels can increase the tendency toward trusting behaviors.

---

[187] Alan Hunt. "Anxiety and Social Explanation: Some Anxieties about Anxiety." *Journal of Social History* 32, no. 3 (Spring 1999), 509.

[188] Michael Davis, David L. Walker and Younglim Lee. "Amygdala and Bed Nucleus of the Stria Terminalis: Differenctial Roles in Fear and Anxiety Measured with the Acoustic Startle Reflex." *Philosophical Transactions: Biological Sciences* 352, no. 1362 (29 November 1997), 1676.

[189] Karl Ebner, Nadia M. Rupniak, Alois Saria, Nicolas Singewald and Tomas Hoekfelt. "Substance P in the Medial Amygdala: Emotional Stress-Sensitive Release and Modulation of Anxiety-Related Behavior in Rats." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 12 (23 March 2004), 4280.

[190] Frederic Saudou, Djamel Amara, Andree Dierich, Marianne LeMeur, Sylvie Ramboz, Louis Segu, Marie-Christine Buhot and Rene Hen. "Enhanced Aggressive Behavior in Mice Lacking 5-HT 1B Receptor." *Science* 265, no. 5180 (23 September 1994), 1878; Robert Huber, Kalim Smith, Antonia Delago, Karin Isaksson and Edward A. Kravitz. "Serotonin and Aggressive Motivation in Crustaceans: Altering the Decision to Retreat." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 11 (27 May 1997), 5940; Olivier Cases, Isabelle Seif, Joseph Grimsby, Patricia Gaspar, Kevin Chen, Sandrine Pournin, Ulrike Mueller, Michel Aguet, Charles Babinet, Jean Chen Shih and Edward De Maeyer. "Aggressive Behavior and Altered Amounts of Brain Serotonin and Norepinephrine in Mice Lacking MAOA." *Science* 268, no. 5218 (23 June 1995), 1766.

[191] Louis A.Gottschalk, , Walter N. Stone, Goldine C. Gleser and James M. Iacono. "Anxiety Levels in Dreams: Relation to Changes in Plasma Free Fatty Acids." *Science* 153, no. 3736 (5 August 1966), 656.

[192] Thomas S. Smith and Gregory T. Stevens. "Hyperstructures and the Biology of Interpersonal Dependence: Rethinking Reciprocity and Altruism." *Sociological Theory* 20, no. 1 (March 2002), 107.

[193] Ibid., 108.

Even more interestingly, this study linked oxytocin to the complex anxiety-attachment feedback loop. The study noted that "oxytocin changes the habituation threshold for opioids…suggesting that [oxytocin] may work to block tolerance to opioid reward."[194] Essentially, oxytocin lowers the tolerance threshold to opioids within the brain, making one more sensitive to opioid effects. The increased sensitivity to opioids makes social interaction more pleasurable for the individual. Therefore, oxytocin plays an indirect role influencing the psychological rewards perceived by attachment and social interaction, increasing positive social behavior by making it more pleasurable.

More recent studies have also linked oxytocin and anxiety. A 2007 Dutch study found that "oxytocin and attachment seem to interact in suppressing subjective anxiety and physiological stress responses."[195] During that same year, a German study demonstrated that certain types of anxiety, such as maternal separation, can deplete oxytocin in the neurological system and decrease subsequent re-attachment behaviors when reunited with the baby.[196] Thus, the link between oxytocin and anxiety seems to be reciprocal. In other words, higher oxytocin levels within the brain correlate with lower anxiety levels. Conversely, lower oxytocin levels within the brain correlate with higher anxiety levels.

Other naturally produced hormones act to decrease anxiety. With specific relation to anxiety caused by conflict, hormones such as neuropeptide Y, cholecystokinin receptor antagonists, corticotrophin-releasing factor receptor antagonists and benzodiazpines have been reported to work very effectively to reduce the effects of anxiety.[197]

---

[194] Thomas S. Smith and Gregory T. Stevens. "Hyperstructures and the Biology of Interpersonal Dependence: Rethinking Reciprocity and Altruism." *Sociological Theory* 20, no. 1 (March 2002), 122.

[195] Mattie Tops, Jacobien M. van Peer, Jakob Korf, Albertus A. Wijers and Don M. Tucker. "Anxiety, Cortisol and Attachment Predict Plasma Oxytocin." Psychophysiology 44, no. 3 (May 2007), 447.

[196] A. H. Veenema. "Opposite Effects of Maternal Separation on Intermale and Maternal Aggression in C57BL/6 Mice: Link to Hypothalamic Vasopressin and Oxytocin Immunoreactivity." *Psychoneuroendocrinology* 32, no. 5 (April 2007), 450.

[197] John R. Walker and George F. Koob. "Orphan Anxiety." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 26 (23 December 1997), 14218.

## D. AGGRESSION

Aggression, like anxiety, spans both emotional and behavioral connotations. In this thesis, aggression refers more to the emotional connotation: "a predisposition, an attitude of mind, an underlying characteristic whose product is violent action."[198] However, from a behavioral perspective, aggression is not always a negative characteristic. "Aggression is a fundamental behavior that has evolved to help organisms compete for limited resources and, therefore, to guarantee survival of the species."[199] From this standpoint, aggression plays a critical role in overall survival within a hostile environment. Further, aggression plays a key role in maintaining societies: "aggressive behavior is important to the development and maintenance of social structures."[200] Aggressive behavior helps to maintain order, provide authority, define social relationships, enforce social values and endow protection within large social structures. Thus, aggression's overall effects can be beneficial.

From a physiological standpoint, aggression is merely another neuro-chemical response to stimuli. Experiments have demonstrated that electrical stimulation of the hypothalamus elicits violent reactions from individuals previously shown to be non-violent.[201] During one such experiment, researchers chose cats that would not attack rats when placed in the same cage. These cats underwent surgery to place an electrode in the hypothalamic region. The electrode could be remotely activated to provide stimulus to

---

[198] James C. Davies. "Violence and Aggression: Innate or Not?" *The Western Political Quarterly* 23, no. 3 (September 1970): 611-623, 613.

[199] Tim Karl, Shu Lin, Christoph Schwarzer, Amanda Sainsbury, Michelle Couzens, Walter Wittmann, Dana Boey, Stephan von Hoersten, Herbert Herzog and Tomas Hoekfelt. "Y1 Receptors Regulate Aggressive Behavior by Modulating Serotonin Pathways." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 34 (24 August 2004), 12742.

[200] Caldwell, H.K. and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006, 589.

[201] Michael Smith. "Pentagon Planned Love Bomb" [article on-line]. London: Daily Telegraph, 2005, accessed 9 November 2007; available from http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2005/01/15/wlove15.xml&sSheet=/news/2005/01/15/ixnewstop.html; Internet, 900; M. David Egger and John P. Flynn. "Amygdaloid Suppression of Hypothalamically Elicited Attack Behavior." *Science* 136, no. 3510 (6 April 1962), 43.

the hypothalamus. "Nine of the ten operated cats, when stimulated in the hypothalamus, savagely attacked a rat placed in the cat's cage. The attack ceased immediately when the stimulation was turned off."[202]

Subsequent studies demonstrated that other neurological factors can mitigate the violent reactions of stimuli to the hypothalamus. For example, "lesions in the dorsal periaqueductal gray region suppressed or completely blocked the attack elicited by thalamic stimulation."[203] Neurochemical reactions can also alter aggressive responses. Neuropeptide Y and serotonin have significant impacts on mitigating aggressive behavior.[204] Yet, studies have shown that neurochemical control of aggression is far more complex than control wrought by brain structure. For example, neuropeptide Y is linked specifically to "territorial aggression, not spontaneous aggressive behavior."[205]

Oxytocin's link to aggressive behavior is equally complex. While it is known that "oxytocin and vasopressin have important roles in the regulation of aggression,"[206] those roles are largely determined by the type of aggression and the type of receptor with which oxytocin is reacting. With respect to *offensive* aggression, "injections of oxytocin into the medial preoptic area-anterior hypothalamus can reduce the duration of aggressive behavior."[207] Yet in respect to *defensive* aggression, "injections of oxytocin into the amygdala increases maternal aggressive behavior."[208] It is significant to note that this increase in defensive aggression has only been observed in relation to the maternal bond for offspring. It is unknown whether oxytocin increases defensive aggression in other

---

[202] M. David Egger and John P. Flynn. "Amygdaloid Suppression of Hypothalamically Elicited Attack Behavior." *Science* 136, no. 3510 (6 April 1962), 43.

[203] Richard J. Bandler, Jr, and John P. Flynn. "Neural Pathways from Thalamus Associated with Regulation of Aggressive Behavior." *Science* 183, no. 4120 (11 January 1974), 98.

[204] Tim Karl, Shu Lin, Christoph Schwarzer, Amanda Sainsbury, Michelle Couzens, Walter Wittmann, Dana Boey, Stephan von Hoersten, Herbert Herzog and Tomas Hoekfelt. "Y1 Receptors Regulate Aggressive Behavior by Modulating Serotonin Pathways." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 34 (24 August 2004), 12742.

[205] Ibid., 12746.

[206] Caldwell, H.K. and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006, 589.

[207] Ibid., 590.

[208] Ibid., 589.

contexts. Thus, the type of aggressive behavior and the specific receptors with which oxytocin is reacting greatly influence the overall effect of oxytocin on observable behavior. Therefore, the context of the situation is equally important as the presence of the chemical.

On a more general level, aggression and trust seem to be related indirectly. Aggressive responses are processed within the periaqueductal gray, which is triggered by stimuli from the amygdala—the part of the brain that makes fear and trust decisions. While the amygdala receives stimuli from nearly every other part of the brain, the amygdala is heavily influenced by chemicals produced by the hypothalamus, the organ that elicits uncontrolled attack behaviors in the studies discussed above. Thus, the amygdala plays middleman between the hypothalamus and periaqueductal gray. Essentially, the trust function of the amygdala tempers aggression, and depleted trust removes restrictions on aggressive responses.

## E. PATHOLOGIES

The possibility of encountering individuals with social pathologies is not uncommon; however, the duties of law enforcement and military personnel put them at heightened risk when encountering individuals with such disorders. Some examples of social pathologies are discussed briefly below.

### 1. Schizophrenia

Schizophrenia is a mental illness primarily manifesting itself in symptoms of impaired capability to properly perceive reality, notably in regard to auditory hallucinations (i.e., 'the voices told me to do it').[209] Though the causes of schizophrenia are complex, one of the consistent neurochemical characteristics of schizophrenia is increased dopamine activity (both more dopamine and more dopamine receptors) in the

[209] Andre Aleman, Edward H. F. de Haan, Stacy A. Castner, Graham V. Williams and Patricia S. Goldman-Rakic. "Antipsychotics and Working Memory in Schizophrenia." *Science* 289, no. 5476 (7 July 2000), 56.

striatum (part of the midbrain).[210] Effective treatment of schizophrenia usually includes a dopamine antagonist. Schizophrenia sufferers are usually non-violent, more often plagued with problems such as catatonia and lack of motivation. Given this fact, law enforcement and military officials are more likely to encounter schizophrenics as victims rather than perpetrators.[211]

Since schizophrenia negatively impact an individuals readiness to engage in social situations, oxytocin could help law enforcement and military personnel to interact with schizophrenic individuals by increasing the schizophrenic's readiness to engage. Unfortunately, there are no existing studies on the effects of oxytocin's ability to increase social interaction among schizophrenics. Though a superficial perspective seems to indicate that oxytocin would have a positive affect, more study is needed in this area.

### 2. Paranoia

Paranoia is a heightened sense of anxiety or fear, sometimes accompanied by delusional tendencies.[212] Paranoia is generally considered to be a mental illness, though there is some contention on that issue.[213] Currently, the prescribed treatment for paranoia does not include medications, as the act of prescribing medication tends to heighten paranoid patients' suspicions sometimes resulting in withdrawal from therapy.[214] However, given the similarities to general fear and anxiety, it is possible that hormones such as oxytocin and serotonin could mitigate the effects of paranoid delusions. No research on this could be found; therefore, it may be a good candidate for exploration.

---

[210] Philip Seeman and Shitij Kapur. "Schizophrenia: More Dopamine, More D2 Receptors." *Proceedings of the National Academy of Sciences of the United States of America* 97, no. 14 (5 July 2000), 7673.

[211] J. S. Brekke, C. Prindle, S. W. Bae and J. D. Long. "Risks for Individuals with Schizophrenia Who Are Living in the Community." *Psychiatric Service* 52, no. 10 (October 2001), 1366; P. B. Fitzgerald, A. R. de Castella, K. M. Filia, S. L. Filia, J. Benitez and J. Kulkarni. "Victimization of Patients with Schizophrenia and Related Disorders." *Australia/New Zealand Journal of Psychiatry* 39, no. 3 (March 2005), 174.

[212] D. Freeman and P.A Garety. *Paranoia: The Psychology of Persecutory Delusions*. Hove: Psychology Press, 2004, 11.

[213] Martin Kantor. *Understanding Paranoia: A Guide for Professionals, Families, and Sufferers*. Westport: Praeger Press, 2004, 27

[214] Ibid., 67.

### 3. Impulsive Aggressive Disorders

"Impulsive aggressive disorders result from the inability to control one's impulses."[215] Road rage and Intermittent Explosive Disorder are two examples of impulsive aggressive disorder.[216] It has been posited that "impulsive aggression is associated with a low threshold for activating negative affective emotions and with a failure to respond appropriately to the anticipated negative consequences of behaving aggressively."[217] Tryptophan depletion has also been implicated as a possible cause for impulsive aggressive behavior.[218]

While some impulsive aggressive disorders such as road rage may be more closely associated with neuroses, disorders such as Intermittent Explosive Disorder are exceptionally similar to specific neurophysiological problems. "Lesions to the orbital and medial prefrontal cortex and anatomically connected areas, including the amygdala, cause patients to develop impulsive and aggressive behavior, show little control over their emotions and be unaware of the implication of their actions....Patients with impulsive aggression performed similarly to patients with orbital frontal and amygdala lesions."[219]

Studies on persons suffering from aggressive disorders demonstrate that these individuals "have a negative attribution bias that affects their ability to interpret social situations correctly."[220] In tests where subjects were asked to identify facial expressions,

---

[215] Mary Best, J. Michael Williams and Emil F. Coccaro. "Evidence for a Dysfunctional Prefrontal Circuit in Patients with an Impulsive Aggressive Disorder." *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 12 (11 June 2002):, 8448.

[216] Ibid., 8448.

[217] Richard J. Davidson, Jeffrey S. Maxwell and Alexander J. Shackman. "The Privileged Status of Emotion in the Brain." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 33 (17 August 2004), 591.

[218] Ibid., 592.

[219] Mary Best, J. Michael Williams and Emil F. Coccaro. "Evidence for a Dysfunctional Prefrontal Circuit in Patients with an Impulsive Aggressive Disorder." *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 12 (11 June 2002), 8448-8451.

[220] Mary Best, J. Michael Williams and Emil F. Coccaro. "Evidence for a Dysfunctional Prefrontal Circuit in Patients with an Impulsive Aggressive Disorder." *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 12 (11 June 2002), 8451.

"subjects with Intermittent Explosive Disorder made more errors and were biased to perceive negative facial expressions."[221] Given this remarkable similarity to the problems associated with autistic individuals, it is possible that oxytocin could significantly affect aggressive impulsive behavior. However, no studies were found that confirm or refute this assumption.

## F. CONCLUSION

The full spectrum of law enforcement and military scenarios often include a complex mix of elicited emotions and behaviors which further complicate the trust-building process during resolution of the situation. It is possible that oxytocin could help to mitigate many of these factors, further contributing toward acceleration of the trust-building process.

Now that a foundation for understanding oxytocin and its effects on trust has been established, attention will turn toward the applicability of this resource toward resolution of law enforcement and military situations. The next chapter focuses on recommendations for using oxytocin in specific law enforcement and military scenarios.

[221] Mary Best, J. Michael Williams and Emil F. Coccaro. "Evidence for a Dysfunctional Prefrontal Circuit in Patients with an Impulsive Aggressive Disorder." *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 12 (11 June 2002), 8450.

# IV. POTENTIAL LAW ENFORCEMENT/MILITARY APPLICATIONS FOR OXYTOCIN

This chapter delves into specific potential law enforcement and military applications for oxytocin. Scenarios depicted in this chapter are considered relatively common social scenarios where rapid trust-building is paramount for successful termination of the scenario but the trust-building process is hindered by various mitigating social or situational factors. The application of oxytocin could realistically be expected to ameliorate mitigating social or situational factors in each scenario based on data presented in previous chapters.

Scenarios are divided into three distinct categories based on the amount of expected exposure time to oxytocin: short-duration exposure, medium-duration exposure and long-duration exposure. Expected benefits and recommended hormone combinations (if applicable) are presented within each scenario synopsis. Recommended administration procedures precede the scenario descriptions. A table encapsulating the data presented in this chapter is presented in the concluding paragraph.

## A. RECOMMENDED ADMINISTRATION TECHNIQUE

Naturally, to be functionally influential, oxytocin must be effectively administered. The following paragraphs review various administration methods including ingestion, injection, absorption and inhalation.

### 1. Ingestion

Ingestion, as an administration method for most hormones, is unlikely to be successful. Because oxytocin and many other hormones are broken down by the digestion system before they enter the bloodstream,[222] ingested hormones do not produce expected results. Therefore, for the scenarios explored in this thesis, ingestion is not recommended as an administration technique.

[222] John H. Martin. *Neuroanatomy: Text and Atlas.* NYC: McGraw-Hill, 2003, 357.

### 2. Injection

Injection methods solve the problem of bypassing the digesting system; however, injection methods present their own set of difficulties. Injection is an invasive technique—forcefully inserting its payload into the bloodstream. (note that injection refers to the act of injecting oxytocin into areas other than the brain; injection of oxytocin directly into the brain is not recommended as a law enforcement or military operational technique) Even when an individual is expecting an injection, as with a vaccination, the process of injecting material into the bloodstream involves apprehension, physical pain and anxiety (in extreme cases). When the individual is an unwilling recipient to an injection, these problems are multiplied considerably. An unexpected or forced injection to an unwilling subject can increase detrimental emotions and behaviors such as fear, aggression, anxiety and distrust which further complicate law enforcement and military scenarios. Additionally, forced injections can activate the body's defense systems, increasing epinephrine and other reactionary mechanisms which can erode the desired effects of oxytocin.

Finally, oxytocin injected into areas other than the brain will encounter a physical barrier that essentially blocks direct interaction with the brain centers that process trust decisions. The brain is protected from many chemicals in the blood by the blood brain barrier, a membrane that effectively strains the blood to protect the brain from elements that could harm the brain.[223] The blood brain barrier is composed of special cells, called epithelial cells, which are tightly packed around each capillary bed.[224] Epithelial cells actually exist around capillary beds throughout the body; however, in the brain these cells are packed much more tightly than elsewhere in the body and more selectively restrict passage of elements from the blood to the brain.[225] Oxytocin and many other hormones are too large to pass through the blood brain barrier; therefore, oxytocin administered via injection is unlikely to affect trust decisions. However, it should be noted that there are

[223] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet.

[224] John H. Martin. *Neuroanatomy: Text and Atlas.* NYC: McGraw-Hill, 2003, 96.

[225] John H. Martin. *Neuroanatomy: Text and Atlas.* NYC: McGraw-Hill, 2003, 96.

no existing studies that compare the effects of oxytocin on trust when administered via injection versus other means.

### 3. Skin Absorption

Skin absorption is another viable method for administering medications and hormones. The skin is a very absorbent membrane. Foams laced with oxytocin could plausibly deliver an effective dose of oxytocin to the body via skin pores. Skin absorption is a passive technique, unlike the forcefulness of injection, and would not be likely to activate the body's defense mechanisms; however, subjects may interpret the foam as an aggressive act.

Despite averting the problems of invasiveness presented by the injection method, oxytocin delivered via skin absorption methods still has to contend with the same physical obstacle: the blood brain barrier. However, oxytocin may have a back door to the brain that bypasses the blood brain barrier. Oxytocin is known to be the only hormone that presents a positive feedback loop with the brain—as demonstrated by oxytocin's role in uterine contractions. Oxytocin receptors inhabit the spinal cord and brain stem in significant quantities, and oxytocin may influence the brain indirectly via signals passed from the spinal cord to the brain through the vagus nerve. The vagus nerve is one of twelve cranial nerves; however, the vagus nerve is the only nerve that extends from the brain stem all the way down to the abdomen. Therefore, the vagus nerve is a central pathway for feedback loops that control heart rate, blood pressure, pain sensation and orgasm. A pathway from the brain to the uterus and vagina has been traced through the vagus nerve,[226] and oxytocin is the primary hormone in the feedback loop between the brain and uterus.

Based on this information, it is plausible that oxytocin present in the blood can react with the brain via the vagus nerve.[227] However, the extent to which this can occur

---

[226] B.R. Komisaruk, B. Whipple, A. Crawford, S. Grimes, W-C. Liu, A. Kalin, and K. Mosier. "Brain activation during vaginocervical self-stimulation and orgasm in women with complete spinal cord injury: fMRI evidence of mediation by the Vagus nerves." *Brain Research* 1024 (2004), 78.

[227] Kerstin Uvnas Moberg and Roberta Francis. *The Oxytocin Factor: Tapping the Hormone of Love, Calm and Healing.* Cambridge, MA: Da Capo Press, 2003, 42.

must be established through further research. As discussed in Chapter I, oxytocin has a relatively short pharmacological effectiveness (3-10 minutes) in the body. Therefore, the question remains whether significant blood oxytocin levels can effectively influence the trust centers of the brain via an indirect path through the vagus nerve.[228] Until this question can be answered, the effectiveness of oxytocin delivery via skin absorption methods cannot be determined.

### 4. Inhalation

Inhalation presents a more direct pathway to the brain through the olfactory system. Sensory nerves within the nasal cavity can be excited by a wide range of molecules, including hormones. Signals from these nerves flow across an olfactory path—from the olfactory nerve to the olfactory bulb to the olfactory cortex.[229] Several studies have linked the olfactory bulb to reactions within other brain structures including the amygdala.[230] In fact, the lateral olfactory tract links directly with the amygdala.[231] This strong connection allows the olfactory senses (primarily smell, but taste to a much lesser extent) to exact considerable influence over brain functions controlled by the amygdala including fear responses, memory formation and trust-building. The olfactory-amygdala connection may be an evolutionary holdover from when smell was a much more prominent detector of danger. In fact, the human nose can detect harmful chemicals at extremely low levels. For example, dimethyl sulfide can be detected at a minimum

---

[228] M. Raggenbass, M. Dubois-Dauphin, S. Charpak, and J. J. Dreifuss. "Neurons in the Dorsal Motor Nucleus of the Vagus Nerve Are Excited by Oxytocin in the Rat But Not in the Guinea Pig." *Proceedings of the National Academy of Sciences of the United States of America* 84, no. 26 (June 1987), 3930.

[229] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet.

[230] John W. Scott and Carl Pfaffmann. "Olfactory Input to the Hypothalamus: Electrophysiological Evidence." *Science* 158, no. 3808 (22 December 1967), 1592; Dennis Shusterman. "Review of the Upper Airway, Including Olfaction, as Mediator of Symptoms." *Environmental Health Perspectives* 110, no. 4 (August 2002), 651; David H. Zald and Jose V. Pardo. "Emotion, Olfaction and the Human Amygdala: Amygdala Activation during Aversive Olfactory Stimulation." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 8 (15 April 1997), 4119.

[231] Henry Gray. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet; John H. Martin. *Neuroanatomy: Text and Atlas.* NYC: McGraw-Hill, 2003, 216.

threshold of .1 parts per million (ppm).[232] This is comparatively low to other thresholds such as the minimum threshold of detecting a minty smell which requires a concentration of 6 ppm of methone or a floral smell which requires a concentration of 300 ppm of phenylethylmethyl ethylcarbinol.[233]

In many of the experiments reviewed for this thesis, including all experiments on human subjects, oxytocin was administered via nasal spray. The effect of the inhaled oxytocin on brain structures is nearly instantaneous. In addition to sidestepping the blood brain barrier entirely, nasal sprays are non-invasive and may go undetected by subjects during intense situations. Thus, the body's defensive mechanisms won't be activated. This can be a crucial factor if covert administration is necessary. Nasal sprays can be administered on a continuous basis by saturating the local environment with the oxytocin spray, extending the effect of oxytocin for periods longer than the average lifespan of a single dosage. Oxytocin sprays can be distributed through a buildings ventilation system should the scenario call for such action. Plus, various devices such as humidifiers can be adapted to distribute atomized quantities of oxytocin spray in smaller closed environments. Open environments, such as the outdoors, may require a heavy-duty misting system deployed from a spray truck or dispersed from an aerial vehicle, however, with heavy concentrations of spray to ensure an adequate dosage is administered.

## B. SHORT-DURATION EXPOSURE SCENARIOS

Short-duration exposure scenarios are defined as scenarios which could be realistically terminated within an hour. Most short-duration exposure scenarios would require only one exposure to oxytocin. End goals of short-duration exposure scenarios would be well-defined and tightly qualified. While total exposure time would depend heavily on the context of the overall situation, subjects generally would be exposed to oxytocin for less than one day.

---

[232] Iowa State University. "The Science of Smell Part 2: Odor Chemistry" [article on-line]. Ames, IA: Iowa State University, 2004, accessed 4 November 2007; available from http://www.extension.iastate.edu/Publications/PM1963B.pdf; Internet.

[233] Iowa State University. "The Science of Smell Part 2: Odor Chemistry" [article on-line]. Ames, IA: Iowa State University, 2004, accessed 4 November 2007; available from http://www.extension.iastate.edu/Publications/PM1963B.pdf; Internet.

### 1. Scenario 1: Child Witness/Victim

Like adults, children have well-developed trust decision-making mechanisms, suggesting that "trusting and trustworthy behavior develop at a very early age and remain relatively consistent into adulthood."[234] However, this also suggests that trust is not easily won, especially in situations where feelings of fear or distrust act to override the tendency to trust, as when a child is the victim of or witness to a serious crime. When interviewing a child victim or witness, a great deal of effort is dedicated to the trust-building process in order to facilitate a relationship where the child feels comfortable enough to relate important details of the crime to the interviewer.[235] This trust-building process can be extensive, given the trauma the child has experienced. However, time is of the essence and facts are needed quickly to resolve the crime.

Oxytocin's trust-enhancing effects could help to shorten the trust-building phase during the interview process of child victims and witnesses. Administration of oxytocin during the initial meeting between the child and the interviewer could engender trusting behavior more rapidly, enhancing the ability to extract crucial information in a shorter timeframe.

A dual-exposure approach may help to yield higher quality information in a compressed timeline. Exposure to oxytocin during the 'meeting' phase between the child and interviewer could establish a trusting foundation. When trust seems to be firmly established, a separate exposure to vasopressin or a memory-enhancing enkephalin could enhance recall capabilities.[236] Vasopressin's effects on mitigating trauma-induced amnesia were discussed in Chapter II. Exposure to vasopressin could help the child to distinguish finer details, such as an accurate answer to questions such as whether the perpetrators hair was brown or black or details about distinguishing marks such as tattoos

---

[234] William T. Harbaugh, Kate Krause, Steven G. Liday Jr. and Lise Vesterlund. "Trust in Children." In *Trust and Reciprocity*, ed. Elinor Ostrom and James Walker, 302-322. NYC: Russell Sage Foundation, 2003, 322.

[235] US Department of Justice. "Child Victims" [article on-line]. Washington, DC: US Department of Justice, 2007, accessed 4 November 2007; available from http://www.ojp.usdoj.gov/ovc/publications/infores/firstrep/chldvics.html; Internet.

[236] Henk Rigter. "Attenuation of Amnesia in Rats by Systemically Administered Enkephalins." *Science* 200, no. 4337 (7 April 1978), 85.

or scars. Since the interview setting can be controlled in this scenario, oxytocin could be released into the air via a humidifier or an atomizing dispersal device such as an aerosol room freshener system. The rate of dispersal and concentration for administering an effective dosage will have to be calculated by a chemist or pharmacist during product design.

### 2. Scenario 2: Suicide Gesture

Each year, an approximate 500,000 individuals receive treatment for self-inflicted wounds.[237] Suicide gestures are time-sensitive scenarios. There is often a short opportunistic timeframe to talk the proverbial 'man on the ledge' down. Suicide gestures are cries for help; however, reactions to the gesture (supportive or derogatory) can dissuade or encourage the individual to carry through the act. The over-riding priority of first-responders is to open positive dialogue and establish an effective rapport with the individual expressing suicidal intentions: "Establishing a rapport with your patient will help you provide effective treatment at the scene….facilitative communication can be useful in establishing a rapport with a person with self-inflicted injuries."[238]

While many suicide gestures are acts of desperation meant to bring attention to a larger problem, a tragic outcome to the gesture is always a possibility. A spectrum of very real and overwhelming emotions underlies the gesture: fear, depression, hopelessness, anxiety, etc. The trust-building qualities of oxytocin could help to establish effective rapport with the individual more rapidly, enhancing the capability of first-responders to conclude the scenario with a positive outcome. This inherently "assumes that administration of oxytocin does not exacerbate feelings of fear and anxiety that could negate oxytocin's effects."[239]

---

[237] Suicide Prevention Resource Center. "First Responders" [article on-line]. Newton, MA: Suicide Prevention Resource Center, 2005, accessed 4 November 2007; available from http://www.sprc.org/featured_resources/customized/first_responders.asp; Internet.

[238] Ibid.

[239] Dorothy Denning, Naval Postgraduate School instructor, interview by author, 14 November 2007, personal

The setting for a suicide gesture is entirely out of the control of first responders. Therefore, the oxytocin administration method will have to vary according to the setting. Oxytocin can be administered more easily in closed environments such as a room or office utilizing humidifiers or aerosol devices as mentioned in Scenario 1. Open environments such as the outdoors present a very different challenge: how to get an effective dosage to the intended individual without affecting bystanders. In this case, a general dispersal method would be inappropriate. If the individual is still only threatening injury, a general administration technique such as a wide-dispersal aerosol spray may be warranted to protect innocent citizens in the vicinity—the use of a general administration technique in such a scenario may have to be set ahead of time by local suicide response guidelines to establish when a general administration of the hormone is warranted. If the individual is already injured, oxytocin could be administered with the impression of spraying an anti-septic or other expected response to an injury, and first responders could simply spray an aerosol treatment of oxytocin in close proximity to the victim.

## C. MEDIUM-DURATION EXPOSURE SCENARIOS

Medium-duration exposure scenarios are defined as scenarios which require more than one exposure to oxytocin over a loosely defined time span—from several hours up to one month in duration. Though end goals of medium-duration exposure scenarios can realistically be well-defined and tightly qualified, situational context and subject-dependent behavior significantly impact goal achievement and, therefore, lengthen the amount of necessary exposure time. While total exposure time would again depend heavily on the context of the overall situation, subjects generally would be exposed to oxytocin for a total amount of time greater than one day but less than one month.

### 1. Scenario 3: Hostage Crisis

"Hostage situations constitute the ultimate form of conflict resolution because, if not managed in an optimal manner, death or serious injury likely can result….a properly handled hostage situation averts catastrophe and creates 'heroes,' while poorly managed

ones create disasters."[240] While some hostage situations end quickly and uneventfully, other hostage negotiations are tense, lengthy procedures[241] that tax responders, victims and perpetrators alike. In either case, "trust is crucial"[242] and the negotiators goals are centered around the "effort to get them over the crisis to end the situation peacefully and nonviolently, thereby saving lives."[243]

Hostage situations are complex in nature, and the art of negotiation is equally complex. Environmental factors provide further obstacles; for example, pervasive fear is a common environmental factor.[244] In situations that conclude quickly and uneventfully, oxytocin will most likely never be a factor in negotiations; however, in drawn-out situations, oxytocin may be an effective tool to advance negotiations, reduce reactivity based on fear and enhance the critical trust relationships between responders and perpetrators—all of which would be conducive to concluding the scenario peacefully and nonviolently. Additionally, the 'mind-reading' effect of oxytocin could provide another benefit in hostage scenarios. The empathy engendered by oxytocin may make perpetrators more sensitive to the emotional trauma of their victims, further encouraging a nonviolent resolution of the situation.

As with suicide attempts, administration technique will vary with the unique setting of each scenario. Assuming the area is accessible by law enforcement/military personnel, humidifiers, aerosols and building ventilation systems can all be used to administer an effective dosage to hostage-takers. The necessity for a more general administration technique requires that specific consideration be paid to the fact that

---

[240] Gregory M. Vecchi. "Hostage/Barricade Management: A Hidden Conflict Within Law Enforcement." [article on-line] Washington, DC: Federal Bureau of Investigations, 2002, accessed 4 November 2007; available from http://www.au.af.mil/au/awc/awcgate/fbi/hostage_mgt.pdf; Internet, 1.

[241] Frederick J. Lancely. "Negotiation Lessons Learned by an FBI Hostage Negotiator." [article on-line] Daytona Beach, FL: Crisis Negotiation Associates, Inc., 2004, accessed 4 November 2007; available from http://www.negotiatormagazine.com/article235_1.html; Internet, 1

[242] Ibid., 4.

[243] Gregory M. Vecchi. "Hostage/Barricade Management: A Hidden Conflict Within Law Enforcement." [article on-line] Washington, DC: Federal Bureau of Investigations, 2002, accessed 4 November 2007; available from http://www.au.af.mil/au/awc/awcgate/fbi/hostage_mgt.pdf; Internet, 2.

[244] Frederick J. Lancely. "Negotiation Lessons Learned by an FBI Hostage Negotiator." [article on-line] Daytona Beach, FL: Crisis Negotiation Associates, Inc., 2004, accessed 4 November 2007; available from http://www.negotiatormagazine.com/article235_1.html; Internet, 3.

hostages will also be affected by artificially-introduced oxytocin, which could increase the occurrence of Stockholm Syndrome in drawn-out scenarios.

### 2. Scenario 4: Infiltration

Infiltration is an extreme tactic utilized by law enforcement and military units to penetrate criminal, gang and other violent organizations. Covert infiltration requires a member to gain membership in the targeted organization, and this act inherently relies on gaining trust from members of the targeted organization.

Infiltration operations carry a significant amount of risk. If the infiltrator is discovered, violence can escalate very quickly. Therefore, extreme measures are taken to minimize the risk of inadvertently exposing an individual attempting to infiltrate an organization. The use of oxytocin during infiltration operations could significantly reduce the amount of risk associated with infiltrating an organization. Oxytocin's trust-enhancing properties could allow an infiltrator to gain the trust of organization leadership and members more effectively, accelerating the processes of establishing trust and gaining meaningful penetration of the organization and its operations.

In this scenario, administration will be problematic. A covert dispersal technique is necessary so as not to arouse suspicion. In situations where the infiltrator can choose the setting, administration can be more easily controlled to ensure an effective dose is administered. However, in situations where the target audience controls the setting, the infiltrating organization is at a disadvantage. Therefore, the uncertainty of this scenario necessitates an administration technique or combination of administration tools that can adapt to a wide variety of settings, from open-air meetings to closed environments that are not accessible prior to meeting times. A considerable amount of research and development may be necessary to produce administration tools dynamic enough to be compatible with the intricacies of this scenario.

### 3. Scenario 5: Riots

Riot control presents another opportunity to utilize the trust-enhancing properties of oxytocin. Long-term law enforcement and military tools for handling riots have

included chemical agents[245] and violent measures up to and including deadly fire.[246] Traditional chemical riot control agents "are chemical compounds that temporarily make people unable to function by causing irritation to the eyes, mouth, throat, lungs and skin."[247] "The major activity [of these agents] is to cause pain, burning or discomfort on exposed mucous membranes and skin."[248]

However, attention among modern law enforcement and military organizations has shifted to less aggressive riot control techniques that permeate the crowd with non-aggression as opposed to inciting a crowd to retaliation via more offensive measures such as bullets or chemical agents.[249] Modern riot control techniques stress "behavioral aspects of crowd and riot control."[250] These techniques include interacting with the crowd in a positive manner: "officers should relax, be friendly, and initiate conversation with individuals in the crowd if possible. Officers should remember that a smile is contagious and will not completely destroy their authority."[251] The use of oxytocin fits well with this new approach. A substantial concentration of oxytocin in aerosol form would provide two primary benefits to the behavioral riot control approach. First,

---

[245] Centers for Disease Control. "Facts About Riot Control Agents" [article on-line]. Atlanta, GA: Centers for Disease Control, 2003, accessed 5 November 2007; available from http://emergency.cdc.gov/agent/riotcontrol/factsheet.asp; Internet.

[246] TIME. "Riot Control: Hold the Street and Seize the High Ground" [article on-line] NYC: Time Magazine, 1967, accessed 5 November 2007; available from http://www.time.com/time/magazine/article/0,9171,837151,00.html; Internet.

[247] Centers for Disease Control. "Facts About Riot Control Agents" [article on-line]. Atlanta, GA: Centers for Disease Control, 2003, accessed 5 November 2007; available from http://emergency.cdc.gov/agent/riotcontrol/factsheet.asp; Internet.

[248] Medical Research Institute of Chemical Defense. "Riot Control Agents" [article on-line]. Aberdeen Proving Ground, MD: United States Army, 1995, accessed 6 November 2007; available from http://www.fas.org/nuke/guide/usa/doctrine/army/mmcch/RiotAgnt.htm; Internet.

[249] Charlie Coon. "Troops Learn Non-Lethal Crowd-Control Techniques" [article on-line]. Boeblingen, Germany: Stars and Stripes, 2006, accessed 5 November 2007; available from https://www.jnlwp.com/Resources/Articles/NonlethalCrowdControl.pdf; Internet; Bruce Rodgers. "Behavioral Aspects of Crowd and Riot Control" [article on-line]. Washington, DC: PoliceLink, 2007, accessed 5 November 2007; available from http://www.policelink.com/training/articles/1828-behavioral-aspects-of-crowd-and-riot-control; Internet; TIME. "Riot Control: Hold the Street and Seize the High Ground" [article on-line] NYC: Time Magazine, 1967, accessed 5 November 2007; available from http://www.time.com/time/magazine/article/0,9171,837151,00.html; Internet.

[250] Bruce Rodgers. "Behavioral Aspects of Crowd and Riot Control" [article on-line]. Washington, DC: PoliceLink, 2007, accessed 5 November 2007; available from http://www.policelink.com/training/articles/1828-behavioral-aspects-of-crowd-and-riot-control; Internet.

[251] Ibid.

oxytocin would help to engender a trust-building relationship between the crowd and on-scene officers. Second, the 'mind-reading' properties of oxytocin would facilitate empathic responses to more relaxed, friendlier officers—essentially encouraging a reciprocal relaxed response from the crowd. If oxytocin's trust-building properties can be significantly produced through the skin absorption administration technique, an oxytocin foam could provide another benefit to riot control efforts: a sense of humor, a riot control technique recommended by the law enforcement community.[252] In addition to trust-building and empathy, the oxytocin foam could produce the same positive behavioral response as a recent popular social trend of flooding clubs and dance floors with soapy foams to make the party more enjoyable. On the flip side, the foam could also be perceived as a potentially harmful/toxic substance, which would then exacerbate the tension of the riot scenario. With some innovation, product developers could create a foam dispersal unit that gives the impression the foam is emanating from an innocuous source to accommodate for this potential. For example, the foam dispersal unit could be masked inside a whipped cream container or soap bottle.

## D. LONG-DURATION EXPOSURE SCENARIOS

Long-duration exposure scenarios are defined as scenarios which require multiple or continuous exposure to oxytocin over an extended timeframe, defined as longer than one month. End goals of long-duration exposure scenarios are loosely-defined and cannot be easily qualified. Situational unpredictability and considerable human factors significantly complicate these scenarios and, therefore, necessitate longer exposure times. Subjects generally would be exposed to oxytocin for more than one month.

### 1. Scenario 6: Inmate Rehabilitation

Americans are very concerned about the level of crime in society and community safety. In a 2006 poll, "74% were somewhat or very concerned about the problem of

[252] Bruce Rodgers. "Behavioral Aspects of Crowd and Riot Control" [article on-line]. Washington, DC: PoliceLink, 2007, accessed 5 November 2007; available from http://www.policelink.com/training/articles/1828-behavioral-aspects-of-crowd-and-riot-control; Internet.

crime in their communities, and 79% are concerned or fearful about the annual release of 700,000 prisoners."[253] Perhaps these fears are somewhat validated by data on criminality and the U.S. prison system:

- more than 94% of offenders will eventually be released from prison and return to our communities[254]
- the U.S. currently holds the highest incarceration rate per capita of all western nations[255]
- during the past decade, the U.S. prison population has more than tripled[256]
- the U.S. maintains a massive prison system that absorbs $40 billion per year.[257]
- states currently spend more on prisons than they do on health, education or housing programs.[258]
- over 47 million Americans have a criminal history on file with state or federal governments. That means about 25 percent of the nation's adult population live a substantial portion of their lives having a criminal record.[259]

"Since the late eighteenth century, prisons have combined elements of punishment with elements of rehabilitation….punishment shifted from the disciplining of the body to the disciplining of the soul."[260] A 2006 poll showed that, after 300 years,

---

[253] Barry Krisberg and Susan Marchionna. "Attitudes of US Voters toward Prisoner Rehabilitation and Reentry Policies" [article on-line]. Washington, DC: National Council on Crime and Delinquency, 2006, accessed 5 November 2007; available from http://fwww.famm.org/Repository/Files/Attitudes_of_US_Voters_toward_Prisoner_Rehabilitation_and_Reentry_Policies%5B1%5D.pdf; Internet, 1.

[254] National Emotional Literacy Project for Prisoners. "Corrections in the US: The Picture Today" [article on-line]. Washington, DC: Lionheart Foundation, 1998, accessed 5 November 2007; available from http://www.lionheart.org/prison_proj/corrections.html; Internet.

[255] Ibid.

[256] Ibid.

[257] Ibid.

[258] Ibid.

[259] Elaine L. Chao. "From Hard Time to Full Time" [article on-line]. Washington, DC: US Department of Labor, 2001, accessed 5 November 2007; available from http://www.hirenetwork.org/pdfs/From_Hard_Time_to_Full_Time.pdf; Internet, 2.

[260] Politics.co.uk. "Prison Rehabilitation" [article on-line] London: politics.co.uk, 2007, accessed 4 November 2007; available from http://www.politics.co.uk/issue-briefs/public-services/prisons/prison-rehabilitation/prison-rehabilitation-$366690.htm; Internet.

most Americans still strongly advocate inmate rehabilitation as opposed to simply punishment: "by almost an eight to one margin, the U.S. voting public is in favor of rehabilitative services for prisoners."[261] Additionally, "when asked about pending legislation that would allocate federal dollars to prisoner reentry, 78% were in support. Of those, almost half expressed strong support."[262] Therefore, the focus of the current prison model in the U.S. is on rehabilitation and preparing the inmate for reentry to society.

Rehabilitation comes at great cost though—roughly $40 billion per year according to the statistics above. Perhaps oxytocin could enhance the rehabilitation process and cut overall costs for programs that pursue prisoner reentry into society. Oxytocin could be a critical element in the early phase of the rehabilitation process, helping to build stronger trust relationships between newly incarcerated inmates and social workers more rapidly. Aerosol dispersal systems could saturate the environment in areas where inmates and social workers meet, helping to create an atmosphere more conducive to trust as inmates and social workers begin to interact. This early environmental change could have long-lasting beneficial effects across the rehabilitation timeline, cutting the time and effort needed to get buy-in from the prisoner. Obviously, more research is needed here to confirm this proposition; however, that research money could be a wise investment toward shrinking the $40 billion annual prison system expenditures.

### 2. Scenario 7: Insurgency

Violent insurgencies are difficult to contain. Distrust, fear and a range of other emotions quickly erupt into offensive and defensive violence as rule of law melts down. The need to rebuild basic social capital elements such as trust is necessary to ending insurgency-related violence. Only when the integrity of social fabric is restored can rule of law be maintained. However, insurgencies contain several inherent obstacles toward

[261] Barry Krisberg and Susan Marchionna. "Attitudes of US Voters toward Prisoner Rehabilitation and Reentry Policies" [article on-line]. Washington, DC: National Council on Crime and Delinquency, 2006, accessed 5 November 2007; available from http://fwww.famm.org/Repository/Files/Attitudes_of_US_Voters_toward_Prisoner_Rehabilitation_and_Reentry_Policies%5B1%5D.pdf; Internet, 1.

[262] Ibid., 1.

quick and easy resolution. One central obstacle is that insurgents can hide among the resident population, essentially crippling the capability to identify the enemy from the ally. The overriding problem to resolving insurgencies has been to identify and eliminate the insurgent population without further alienating the peaceful population or causing violence to escalate in an ever-bloodier cycle of violence.

It is plausible that mass dispersal of oxytocin could help to ameliorate the difficulties of counter-insurgency techniques by facilitating trust among the resident communities and overall society. If oxytocin could have a significant effect on rebuilding the social capital element of trust, there may be a corresponding, though quite indirect, drop in fear and aggression among the populace. This is obviously very difficult to prove without empirical evidence; however, the possible gains certainly warrant further research, especially in light of the situation in Iraq where civilian death toll estimates from insurgent violence range from 80,000 to 655,000.[263]

## E. NON-COGNITION REVISITED

In Chapter I, the concept of non-cognitive trust was discussed at length. While it may have seemed to be an arbitrary discussion at the time, the influence of oxytocin on the non-cognitive aspect of trust is relevant in many of the applications discussed in this chapter. It is possible that oxytocin's influence on trust-building is most effective when the effect on trust-building does not breach to the cognitive level. This notion, of course, suggests that administration of the oxytocin should be covert—completely unknown to the subject. In the cases of infiltration and hostage crisis situations, the covert aspect of oxytocin administration may be necessary to achieve any of the desired effects. In the cases of child witness/victim interviews, suicide gestures or inmate rehabilitation scenarios, the administration technique could be overt without sacrificing effect. Though, this is purely assumptive. However, it is equally plausible that the effects of oxytocin may be strong enough that cognition of its application may not diminish the desired

[263] David Brown. "Study Claims Iraq's 'Excess' Death Toll Has Reached 655,000" [article on-line]. Washington, DC: Washington Post, 2006, accessed 6 November 2007; available from http://www.washingtonpost.com/wp-dyn/content/article/2006/10/10/AR2006101001442.html; Internet; Iraq Body Count. "Iraq Body Count" [article on-line]. Washington, DC: Iraq Body Count, 2007, accessed 6 November 2007; available from http://www.iraqbodycount.org/; Internet.

result. Ultimately, the necessity for covert administration needs to be tested in laboratory experiments.

**Recap of Potential Law Enforcement/Military Applications for Oxytocin**

| Scenario | Positive Oxytocin Side Effects | Administration |
|---|---|---|
| Child Witness/Victim | rapid trust-building, increased sociability | air saturation via humidifier |
| Suicide Gesture | rapid trust-building, increased sociability | aerosol spray |
| Hostage Crisis | rapid trust-building, increased sociability, increased empathy | air saturation via ventilation system or general aerosol spray |
| Infiltration | rapid trust-building | air saturation via humidifier or ventilation, if circumstances permit |
| Riot Control | increased sociability, increased empathy | general aerosol spray or foam |
| Inmate Rehabilitation | rapid trust-building, increased sociability | air saturation via humidifier |
| Insurgency | rapid trust-building, increased sociability | general aerosol spray |

Table 4. Recap of Potential Law Enforcement/Military Applications for Oxytocin

## F. CONCLUSION

These seven examples illustrate potential usage for oxytocin in the law enforcement and military fields. Oxytocin could prove to be a significant enabler to non-violent conclusions to common law enforcement and military scenarios. As discussed throughout this chapter, oxytocin is not meant to replace current techniques for handling these situations. Instead oxytocin would enhance the effectiveness of proven situational techniques by enhancing trust-building capabilities in urgent scenarios. Oxytocin administration techniques and devices would be cost-effective tools for enhancing the capabilities of both law enforcement and military personnel to serve and protect the people. Given this perspective, it is also important to point out that there are a lot of

technical issues yet to be overcome before oxytocin can be utilized in law enforcement and military applications. Some of these issues include determination of effective dosage, effective administration and effective doctrine. The next chapter focuses on ethical and legal issues surrounding the deployment of oxytocin techniques and devices for law enforcement and military scenarios.

THIS PAGE INTENTIONALLY LEFT BLANK

# V. ETHICS AND LEGALITY OF OXYTOCIN APPLICATIONS

Though chemicals are commonly used in everyday life, biological and chemical applications carry significant social weight. Consider the recent news story about the popular toy, Aquadots, that contains a "chemical that, once metabolized, converts into the toxic "date rape" drug GHB (gamma-hydroxy butyrate)."[264] Several children ingested toy parts and experienced severe medical consequences. Manufacturers recalled 4.2 million of the seemingly innocuous toys in response to the crisis.[265]

This chapter examines ethical and legal issues surrounding the potential uses for oxytocin in law enforcement and military scenarios. The intent of this chapter is to provide an objective analysis of the implications of using chemicals on public citizens, with special attention to the implications of covertly deploying chemical products on unwitting subjects. While several observations may seem to provide arguments against utilization of the techniques offered in the previous chapter, the overall intent is to draw attention to the many complex social issues that should be considered before deploying a chemical or biological capability.

## A. NON-LETHAL VS. LETHAL

Research into non-lethal methods of combating enemy forces and dispersing riots has gained significant attention. Non-lethal implementations have been explored in order to "reduce the number of casualties."[266] Instead, these weapons would effectively debilitate the enemy by "affecting human behavior so that discipline and morale in enemy units is adversely affected."[267] Examples of non-lethal implementations include

---

[264] Janine Brady, Jason Carroll, Laura Dolan and Leslie Wiggin. "Report: China halts export of bead toys tainted with toxic drug" [article on-line]. Atlanta, GA: CNN, 2007, accessed 9 November 2007; available from http://www.cnn.com/2007/WORLD/asiapcf/11/09/toy.recall/index.html; Internet.

[265] Ibid.

[266] Jeremy, Bransten. "US: Pentagon Unveils the Next Generation of Nonlethal Weapons" [article on-line]. Alexandria, VA: globalsecurity.org, 2007, accessed 9 November 2007; available from http://www.globalsecurity.org/military/library/news/2007/01/mil-070130-rferl02.htm; Internet.

[267] Michael Smith. "Pentagon Planned Love Bomb" [article on-line]. London: Daily Telegraph, 2005, accessed 9 November 2007; available from http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2005/01/15/wlove15.xml&sSheet=/news/2005/01/15/ixnewstop.html; Internet.

valium sprays, the 'gay bomb,' and millimeter wave guns which produce "an instant burning sensation that forces a retreat,"[268] "The Pentagon also considered chemicals that would make the enemy troops sexually attractive to 'annoying or injurious animals' such as stinging and biting bugs or rodents."[269] Oxytocin reasonably falls into the non-lethal category of initiatives.

The underlying intent of such initiatives is lofty: to win the conflict without resorting to bloodshed and violence. So, on the surface, it would appear there is no downside with developing and using such implementations. However, public opinion does not always support that perspective. After the initial snickers ended, the gay bomb was derided as a reprehensible idea whose prospects of effectiveness were slim at best.[270] Valium sprays constitute a chemical attack, banned by international law. Millimeter wave guns are non-lethal only if use is restricted to a short timeframe, usually 3-5 seconds.[271] If the millimeter wave is directed at a target for eight seconds or longer, second- and third-degree burns can be inflicted on the target;[272] therefore, this weapon is not necessarily non-lethal.

Constraints inflicted by negative public opinion, legal limitations and potential lethality could also affect oxytocin implementations. As stated earlier in this thesis, the effectiveness of oxytocin in the scenarios described must be tested with laboratory research. The public could also react adversely to the use of oxytocin in law enforcement

---

[268] Jeremy, Bransten. "US: Pentagon Unveils the Next Generation of Nonlethal Weapons" [article on-line]. Alexandria, VA: globalsecurity.org, 2007, accessed 9 November 2007; available from http://www.globalsecurity.org/military/library/news/2007/01/mil-070130-rferl02.htm; Internet; Hank Plante. "Pentagon Confirms It Sought to Build a 'Gay Bomb'" [article on-line]. Berkeley, CA: CBS News, 2007, accessed 9 November 2007; available from http://cbs5.com/topstories/local_story_159222541.html; Internet.

[269] Michael Smith. "Pentagon Planned Love Bomb" [article on-line]. London: Daily Telegraph, 2005, accessed 9 November 2007; available from http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2005/01/15/wlove15.xml&sSheet=/news/2005/01/15/ixnewstop.html; Internet.

[270] Hank Plante. "Pentagon Confirms It Sought to Build a 'Gay Bomb'" [article on-line]. Berkeley, CA: CBS News, 2007, accessed 9 November 2007; available from http://cbs5.com/topstories/local_story_159222541.html; Internet.

[271] Jeremy, Bransten. "US: Pentagon Unveils the Next Generation of Nonlethal Weapons" [article on-line]. Alexandria, VA: globalsecurity.org, 2007, accessed 9 November 2007; available from http://www.globalsecurity.org/military/library/news/2007/01/mil-070130-rferl02.htm; Internet

[272] Ibid.

and military scenarios, viewing oxytocin implementations as infringements on civil and human rights as opposed to a public good. Additionally, use of oxytocin in scenarios involving the general public could produce negative health effects to unborn fetuses, pregnant women and individuals with compromised immune systems. Therefore, careful consideration is necessary before deploying any new chemical or biological method.

## B. HISTORY OF COVERT TESTING

A dark history of covert drug testing acts to degrade public opinion of chemical and biological implementations on the general public, especially covertly. The CIA conducted several programs, such as MKULTRA and BLUEBIRD, to test chemical and biological effects on human behavior.[273] "It was disclosed by Senate Committees investigating the activities of the CIA in 1977 that the Agency was involved in testing drugs like LSD on 'unwitting subjects in social situations."[274] Project CHATTER, another CIA initiative in the use of chemicals to control human behavior, experimented with toxins such as scopolamine and psychedelics such as mescaline.[275]

These projects often involved subjects forced or mislead into participating.[276] "At Fernald School, Massachusetts Institute of Technology gave radioactive substances to children by putting it in their food. No risks of radioactivity were mentioned in the

[273] Colin A. Ross. "BLUEBIRD: Deliberate Creation of Multiple Personality by Psychiatrists" [article on-line]. Berkeley, CA: wanttoknow.info, 2005, accessed 8 November 2007; available from http://www.wanttoknow.info/bluebird10pg; Internet, 3.

[274] Defense Oversight Group. "Results of the 1973 Church Committee Hearings on CIA Misdeeds and the 1984 Iran Contra Hearings" [article on-line]. Washington, DC: Civil Intelligence Association, 2007, accessed 9 November 2007; available from http://pw1.netcom.com/~ncoic/cia_info.htm#Table%20of%20Contents; Internet.

[275] Ibid.

[276] Colin A. Ross. "BLUEBIRD: Deliberate Creation of Multiple Personality by Psychiatrists" [article on-line]. Berkeley, CA: wanttoknow.info, 2005, accessed 8 November 2007; available from http://www.wanttoknow.info/bluebird10pg; Internet, 4; Defense Oversight Group. "Results of the 1973 Church Committee Hearings on CIA Misdeeds and the 1984 Iran Contra Hearings" [article on-line]. Washington, DC: Civil Intelligence Association, 2007, accessed 9 November 2007; available from http://pw1.netcom.com/~ncoic/cia_info.htm#Table%20of%20Contents; Internet; Committee on Veteran's Affairs. "Is Military Research Hazardous to Veterans' Health? Lessons Spanning Half a Century" [report on-line]. Washington, DC: United States Senate, 1994, accessed 14 November 2007; available from http://www.gulfweb.org/bigdoc/rockrep.cfm#hallucinogens; Internet.

consent forms signed by the parents."[277] As concluded by a Senate investigation on such activities, "most Americans would agree that the use of unwitting guinea pigs in experiments that were designed to harm them is not ethical."[278] In fact, two prominent international treaties have designated experimentation on unwitting subjects as illegal: the Nuremberg Code and the Helsinki Declaration. According to the Nuremburg Code, "the persons involved should have the legal capacity to give consent; should be so situated as to be able to exercise free power of choice…."[279]

"There is abundant evidence in the public domain that non-lethal weapons research is ongoing and funded in the tens of millions of dollars….it is possible that non-lethal weapons have also been tested on unwitting civilians."[280] Evidently, a level of concern, even fear, exists over the deployment of chemical and biological agents against the population. Deployment of any oxytocin implementation will most likely fall under scrutiny of these concerns. Obviously, the history presented here could negatively impact the use of oxytocin in law enforcement and military scenarios.

## C. BIOLOGICAL WEAPONS CONVENTION AND CHEMICAL WEAPONS CONVENTION

The Biological Weapons Conference is an international treaty signed by 143 countries[281] outlawing the "development, stockpiling, acquisition, retention and production of biological arms that have no justification for protective or peaceful

[277] Colin A. Ross. "BLUEBIRD: Deliberate Creation of Multiple Personality by Psychiatrists" [article on-line]. Berkeley, CA: wanttoknow.info, 2005, accessed 8 November 2007; available from http://www.wanttoknow.info/bluebird10pg; Internet, 3.

[278] Committee on Veteran's Affairs. "Is Military Research Hazardous to Veterans' Health? Lessons Spanning Half a Century" [report on-line]. Washington, DC: United States Senate, 1994, accessed 14 November 2007; available from http://www.gulfweb.org/bigdoc/rockrep.cfm#hallucinogens; Internet.

[279] Ibid.

[280] Colin A. Ross. "BLUEBIRD: Deliberate Creation of Multiple Personality by Psychiatrists" [article on-line]. Berkeley, CA: wanttoknow.info, 2005, accessed 8 November 2007; available from http://www.wanttoknow.info/bluebird10pg; Internet, 10.

[281] Office of Defense Nuclear Nonproliferation. "Biological Weapons Convention" [article on-line]. Washington, DC: National Nuclear Security Administration, 2007, accessed 13 October 2007; available from http://www.nnsa.doe.gov/na-20/bwc.shtml; Internet.

purposes and the weapons, equipment and delivery vehicles"[282] for dispersal of such arms. The definition of biological arms is very broad and even includes the production and use of such off-the-shelf products as mace and pepper spray, which "may be used in military situations by presidential order."[283] If developed as a law enforcement or military application, oxytocin would also fall under the definition of a biological armament under the Biological Weapons Convention. Despite their classification as biological arms, chemicals such as mace, pepper spray and oxytocin are allowed under provisions in the Biological Weapons Convention for biodefense programs.[284] Most law enforcement applications are largely ignored by the Biological Weapons Conference because these applications are used within the national borders on resident citizens; however, military applications are much more scrutinized as military applications can be assumed for use on foreign populations. The Biological Weapons Conference "allows signatory nations to lodge a complaint with the UN Security Council if they suspect other member states are violating the convention."[285] The use of oxytocin on foreign populations in order to suppress insurgencies could likely be viewed as a violation of the Biological Weapons Convention depending on public perceptions of whether such use constitutes a chemical or biological attack.

---

[282] Oliver Meier. "The Biological Weapons Conference at a Glance" [article on-line]. Washington, DC: Arms Control Association, 2006, accessed 13 October 2007; available from http://www.armscontrol.org/pdf/BWCreaderWebVersion.pdf; Internet; Bureau of International Security and Nonproliferation. "Convention of the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction" [article on-line]. Washington, DC: Department of State, 2007, accessed 13 October 2007; available from http://www.state.gov/t/ac/trt/4718.htm; Internet.

[283] Medical Research Institute of Chemical Defense. "Riot Control Agents" [article on-line]. Aberdeen Proving Ground, MD: United States Army, 1995, accessed 6 November 2007; available from http://www.fas.org/nuke/guide/usa/doctrine/army/mmcch/RiotAgnt.htm; Internet.

[284] Oliver Meier. "The Biological Weapons Conference at a Glance" [article on-line]. Washington, DC: Arms Control Association, 2006, accessed 13 October 2007; available from http://www.armscontrol.org/pdf/BWCreaderWebVersion.pdf; Internet; Bureau of International Security and Nonproliferation. "Convention of the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction" [article on-line]. Washington, DC: Department of State, 2007, accessed 13 October 2007; available from http://www.state.gov/t/ac/trt/4718.htm; Internet

[285] Ibid.

The Chemical Weapons Convention is a multilateral arms control treaty signed by 182 countries[286] "that bans chemical weapons and requires their destruction within a specified period of time."[287] More specifically, "the chemical weapons convention bans (1) developing, producing, acquiring, stockpiling, or retaining chemical weapons; (2) the direct or indirect transfer of chemical weapons; (3) chemical weapons use or military preparation for use; (4) assisting, encouraging, or inducing other states to engage in CWC-prohibited activity; (5) the use of riot control agents as a method of warfare."[288] Under the convention, chemical armaments are defined as "toxic chemicals and their precursors… munitions and devices, specifically designed to cause death or other harm through the toxic properties of those toxic chemicals."[289] Riot control agents are defined as "any chemical which can produce rapidly in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure."[290] Based on these definitions, oxytocin does not seem to fall directly under the auspices of the Chemical Weapons Convention. Despite the fact that oxytocin does not currently fit the definition of a chemical or riot control agent, oxytocin's use on a foreign population could elicit a change in classification if the international community agrees that such usage constitutes an unlawful attack on the foreign population.

## D. PHEROMONES AND PUBLIC DISPUTE

Public disputes can arise even when the agent used does not target humans and is publicly announced before administration. An environmental initiative to eradicate an invasive insect species in California sparked significant debate within the community.

---

[286] Organization for the Prohibition of Chemical Weapons. "Status of Participation in the Chemical Weapons Convention" [article on-line]. NYC: United Nations, 2007, accessed 14 November 2007; available from http://www.opcw.org/html/db/members_ratifyer.html; Internet.

[287] Daryl Kimball. "The Chemical Weapons Convention at a Glance" [article on-line]. Washington DC: Arms Control Association, 2007, accessed 14 November 2007; available from http://www.armscontrol.org/factsheets/cwcglance.asp?print; Internet.

[288] Ibid.

[289] Organization for the Prohibition of Chemical Weapons. "Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction" [article on-line]. NYC: United Nations, 2007, accessed 10 November 2007; available from http://www.opcw.org/html/db/cwc/eng/cwc_article_II.html; Internet.

[290] Ibid.

This initiative involved spraying pheromones across Monterey County in order to disrupt the mating cycle of the invasive light brown apple moth. Essentially, the pheromones would overload the senses of the moth, rendering males unable to locate females. Pheromones and hormones are closely linked, and both are naturally produced by living organisms. However, the central dispute was not over the pheromone. Instead, an inert compound called polymethylene polyphenyl isocyanate (PPI) that was alleged to be included in the aerosol spray sparked the debate. PPI would allow the pheromones to time-release into the atmosphere hours after being sprayed, prolonging the disruption of the moth's mating cycle and increasing effectiveness of the technique.[291] "PPI has been linked to health concerns including itchy eyes and respiratory problems."[292] When awareness of the aerosol spray's health concerns reached the public, several lawsuits were filed, including a lawsuit against the California Department of Food and Agriculture "alleging that the spray plan violates state environmental laws."[293] Despite the lawsuits, the aerosol spray initiative was allowed to continue.[294] Later, it was discovered that PPI was not contained in the spray;[295] however, this incident demonstrates how perceptions about chemical sprays and effects on health can quickly incite disputes.

Similar concerns about human endangerment could arise over the use of oxytocin, especially given the health concern of inducing premature contractions in pregnant

---

[291] Kera Abraham. "Flying Right at the Issue: Disclosure of Moth Pheromone Product's Inert Ingredients Incites a Legal Battle" [article on-line]. Monterey, CA: Monterey County Weekly, 2007, accessed 7 November 2007; available from http://www.mcweekly.com/issues/Issue.10-18-2007/news/Article.news_2; Internet.

[292] Ibid.

[293] Kera Abraham. "Flying Right at the Issue: Disclosure of Moth Pheromone Product's Inert Ingredients Incites a Legal Battle" [article on-line]. Monterey, CA: Monterey County Weekly, 2007, accessed 7 November 2007; available from http://www.mcweekly.com/issues/Issue.10-18-2007/news/Article.news_2; Internet; KCBA. "Light Brown Apple Moth Meeting in Monterey" [article on-line]. Monterey, CA: KCBA, 2007, accessed 9 November 2007; available from http://www.kcba.com/news/local/story.aspx?content_id=eab0255e-63fe-4e40-8c26-d6a18e753fb9; Internet.

[294] KCBA. "Light Brown Apple Moth Meeting in Monterey" [article on-line]. Monterey, CA: KCBA, 2007, accessed 9 November 2007; available from http://www.kcba.com/news/local/story.aspx?content_id=eab0255e-63fe-4e40-8c26-d6a18e753fb9; Internet.

[295] Juliana Barbassa. "Judge Says Pesticide Spraying Can Resume on Calif's Central Coast" [article on-line] Monterey, CA: The Monterey Herald, 2007, accessed 14 November 2007; available from http://www.montereyherald.com/search/ci_7227387?IADID=Search-www.montereyherald.com-www.montereyherald.com; Internet.

women. While careful consideration of potential affected individuals during deployment and proper dosage could help to allay some fears, concern over the application of chemicals to the general public could override oxytocin's utility. Water fluoridation presents a notable equivalent. Currently, 67% of U.S. residents receive fluoridated water with the belief that this practice helps to deter tooth decay.[296] However, in 1992, fluoridation equipment for the town of Hooper Bay, Alaska malfunctioned, dumping massive amounts of fluoride into the water supply.[297] Consequently, 296 residents suffered from fluoride toxicity and one person died.[298] Similar incidents have been recorded in Mississippi, New Mexico and Vermont.[299] Thus, a practice deemed a public good carries an inherent risk. As always, the question is whether the benefits outweigh the inherent risks.

## E. SUB-COGNIZANT EFFECTS

Subliminal, sub-cognizant, covert or deceptive practices have, in the past, drawn public ire. Perhaps the most well-known recent incident involving intentionally sub-cognizant influence on the public is the Joe Camel advertising campaign. The cigarette industry knew that, in order to maintain sales levels, new smokers needed to be recruited. Research of potential target audiences demonstrated significant opportunities to recruit young people through advertising techniques. Though RJR Nabisco would later define young people as those under the age of 25, company memos specifically identified

---

[296] Centers for Disease Control. "The Benefits of Fluoride" [article on-line]. Atlanta, GA: Centers for Disease Control, 2005, accessed 9 November 2007; available from http://www.cdc.gov/fluoridation/fact_sheets/benefits.htm; Internet.

[297] B. D. Gessner, M. Beller, J. P. Middaugh and G. M. Whitford. "Acute Fluoride Poisoning From a Public Water System." *New England Journal of Medicine* 330, no. 2 (13 January 1994), 95.

[298] Ibid., 97.

[299] Penman, A. D., P. T. Brackin and R. Embrey. "Outbreak of Acute Fluoride Poisoning Caused by a Fluoride Overfeed, Mississippi 1993." *Public Health Report* 112, no. 5 (September-October 1997, 403; R. Hoffman, J. Mann, J. Calderone, J. Trumbull and M. Burkhart. "Acute Fluoride Poisoning in a New Mexico Elementary School." *Pediatrics* 65, no. 5 (May 1980), 897; R. L. Vogt, L. Witherell, D. LaRue and D. N. Klaucke. "Acute Fluoride Poisoning Associated with an On-site Fluoridator in a Vermont Elementary School." *American Journal of Public Health* 72, no. 10 (October 1982), 1169.

targeting children between the ages of 10-19 years of age.[300] Advertising strategies shifted significantly to include "trademark logos on candy cigarettes, brand appearances in video games, product placements in movies, etc."[301] Additionally, "trade surveys found that billboards are highly effective against the young,"[302] and cigarette companies subsequently boosted outdoor advertising budgets, with billboard advertising comprising the bulk of expenditures at roughly 35.1% of total advertising budgets.[303] "A 1994 Institute of Medicine report noted that 'despite industry standards to the contrary, billboards promoting tobacco consumption can be found near homes, schools, churches, parks, playgrounds and health centers."[304]

These conditions promoted "the impression among children that tobacco use is desirable, socially acceptable and prevalent."[305] However, campaigns were subtle enough as to not overtly seem to be catering to youth—that is, until the cartoon character Joe Camel began appearing in RJR Nabisco advertisements. Independents studies found that children as young as three years old were able to readily identify Joe Camel.[306] When compared to adult populations, children more readily identified with the Joe Camel character: 97.7% of children reported prior exposure to the Joe Camel character versus 72.2% of adults; 97.5% of children were able to recognize the type of product being advertised versus 67.0% of adults; 93.6% of children were able to recognize the brand

[300] Richard W. Pollay. "Protecting Children as Consumers: Comments on Proposed Regulations re: Packaging, Marketing, Distribution and Sales of Cigarettes, Etc." [article on-line]. Vancouver, BC: University of British Columbia, 1998, accessed 9 November 2007; available from http://legacy.library.ucsf.edu/tid/ytk22d00/pdf?search=%22protecting%20children%20as%20consumers%20pollay%22; Internet, 7

[301] Ibid., 8.

[302] Ibid., 11.

[303] Ibid., 9.

[304] Ibid., 11.

[305] Ibid., 15.

[306] J. R. Di Franza, J. W. Richards, P. M. Paulman, N. Wolf-Gillespie, C. Fletcher, R. D. Jaffe and D. Murray. "RJR Nabisco's Cartoon Camel Promotes Camel Cigarettes to Children." *Journal of the American Medical Association* 268, no. 15 (21 October 1992), 2034; P. M. Fischer, M. P. Schwartz, J. W. Richards, Jr., A. O. Goldstein and T. H. Rojas. "Brand Logo Recognition by Children Aged 3 to 6 Years. Mickey Mouse and Old Joe the Camel." *Journal of the American Medical Association* 266, no. 22 (11 December 1991), 3186.

name being advertised versus 57.7% of adults.[307] Consequently, "children also found the Camel cigarette advertisements more appealing. Camel's share of the illegal children's cigarette market segment has increased from 0.5% to 32.8%."[308] Based on the overwhelming evidence, studies concluded that "Joe Camel cartoon advertisements are far more successful at marketing Camel cigarettes to children than to adults."[309]

The strategies used by cigarette manufacturers were both purposeful and covert. The entire campaign strategy was intended to provide sub-cognizant motivators to encourage children to take up smoking. When discovered, the practice was vehemently decried by the public and legal systems.

The use of oxytocin in law enforcement and military applications could be perceived in the same light. The practice could be deemed as a ploy to usurp an individual's ability to control his or her own life or an infringement on basic human rights by manipulating a person's decision-making process via chemical influences intended to lead the individual to a desired conclusion. However, public opinion is fickle. It is equally plausible that the use of oxytocin in law enforcement and military scenarios could be viewed as neutral or even positive by the general public—as innocuous as adding vitamin D to milk or enriching table salt with iodine. Public reaction to the use of oxytocin in applications suggested in Chapter IV is difficult to predict, especially given the heightened sensitivity to health concerns surrounding general chemical dispersal.

## F. MOSCOW THEATER HOSTAGE CRISIS

To illustrate the fickleness of public opinion, it is interesting to note that the majority of "Russians seem to support the action taken by Moscow authorities"[310] during

---

[307] J. R. Di Franza, J. W. Richards, P. M. Paulman, N. Wolf-Gillespie, C. Fletcher, R. D. Jaffe and D. Murray. "RJR Nabisco's Cartoon Camel Promotes Camel Cigarettes to Children." *Journal of the American Medical Association* 268, no. 15 (21 October 1992), 2034.

[308] Ibid., 2034.

[309] Ibid., 2034.

[310] Chemical and Biological Weapons Nonproliferation Program. "The Moscow Theater Hostage Crisis: Incapacitants and Chemical Warfare" [article on-line]. Monterey, CA: James Martin Center for Nonproliferation Studies, 2002, accessed 13 October 2007; available from http://cns.miis.edu/pubs/week/02110b.htm; Internet.

the Moscow theater hostage crisis in 2002. Ultimately, it is up to the public to decide what is acceptable and appropriate. In this case, the majority seems to have accepted the practice of using chemicals to conclude a violent situation.

It is imperative to recognize that the methods used to end the Moscow theater hostage crisis differ significantly from the methods described in this thesis. Moscow special forces used a chemical called fentanyl, an incapacitating agent that induces sleep, unconsciousness or euphoria.[311] Fentanyl has been used as a morphine substitute in medical practices since its synthesis in 1963.[312] The scientific community pursued synthesized morphine substitutes in order to increase patient safety, as morphine had a relatively high instance of deadly complications.[313] Fentanyl, along with several other opiates, provided greater leverage between the minimum effective dose and a potentially lethal dose (see table). Fentanyl has a relatively safe margin of error, as the lethal dosage is 277 times the minimum effective dosage.[314] Thus, the Russian government could have been relatively reassured that fentanyl would elicit resultant unconsciousness without a high death rate.

[311] Chemical and Biological Weapons Nonproliferation Program. "The Moscow Theater Hostage Crisis: Incapacitants and Chemical Warfare" [article on-line]. Monterey, CA: James Martin Center for Nonproliferation Studies, 2002, accessed 13 October 2007; available from http://cns.miis.edu/pubs/week/02110b.htm; Internet.

[312] Ibid.

[313] Ibid.

[314] Ibid.

| Opiate | Lowest effective dose, $ED_{50}$ mg/kg | $LD_{50}$, mg/kg | Relative safety index |
|---|---|---|---|
| Meperidine | 6.0 | 29.0 | 4.8 |
| Alfentanil | 0.044 | 47.5 | 1,080 |
| Fentanyl | 0.011 | 3.1 | 277 |
| Sufentanil | 0.007 | 17.9 | 25,211 |
| Lofentanil | 0.0059 | 0.066 | 112 |
| Carfentanil | 0.0034 | 3.4 | 10,000 |

Table 5. Table: Clinical data for fentanyl-based compounds, comparing the effective dose ($ED_{50}$), and the lethal dose ($LD_{50}$) for 50% of a given population.[315]

However, 117 of the hostages inside the theater died from exposure to the fentanyl gas.[316] Evidently, the minimum lethal dosage was exceeded by the particular administration method used by special forces in the Moscow incident. Regardless, as stated earlier, most Russians have concluded that this was an acceptable loss. Perhaps this perception has been influenced by the fact that Russian authorities were battling a vicious terrorist group known to have links with al-Qaeda.[317] Regardless, the Moscow theater crisis provides ample warning that proper administration of any chemical requires extreme care. The minimum effective dosage of oxytocin is 0.5-2 milliunits per minute.[318] An oxytocin overdose is most likely to result in a condition known as water

[315] Chemical and Biological Weapons Nonproliferation Program. "The Moscow Theater Hostage Crisis: Incapacitants and Chemical Warfare" [article on-line]. Monterey, CA: James Martin Center for Nonproliferation Studies, 2002, accessed 13 October 2007; available from http://cns.miis.edu/pubs/week/02110b.htm; Internet.

[316] Chemical and Biological Weapons Nonproliferation Program. "The Moscow Theater Hostage Crisis: Incapacitants and Chemical Warfare" [article on-line]. Monterey, CA: James Martin Center for Nonproliferation Studies, 2002, accessed 13 October 2007; available from http://cns.miis.edu/pubs/week/02110b.htm; Internet; Karon, Tony. "Behind the Moscow Theater Siege" [article on-line]. NYC: Time Magazine, 2002, accessed 13 October 2007; available from http://www.time.com/time/world/article/0,8599,383909,00.html; Internet.

[317] Karon, Tony. "Behind the Moscow Theater Siege" [article on-line]. NYC: Time Magazine, 2002, accessed 13 October 2007; available from http://www.time.com/time/world/article/0,8599,383909,00.html; Internet.

[318] RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet.

intoxication.[319] Water intoxication is "a potentially fatal brain dysfunction resulting in a severe imbalance on electrolytes, which regulate brain operations, and a super-concentration of water."[320] A dosage of 40-50 milliunits per minute constitutes the minimum lethal dosage of oxytocin,[321] giving oxytocin a relative safety index of roughly 25-80, well below the relative safety index of fentanyl (277).

## G. CHEMICALLY ENHANCED TRUST AND DATE RAPE

One of the more abstract concerns about widespread use of oxytocin is that the hormone could be used as a date rape drug: "some researchers note that oxytocin may have potential as a date-rape drug since oxytocin is involved both in trust and in sexual arousal."[322] More commonly, date rape drugs such as ketamine or rohypnol precipitate sedative or amnesiac effects. Oxytocin would represent a significant departure from that classification, as oxytocin produces neither of those effects. Rather, the concern is that the trust-enhancing and sexual-arousal symptoms would precipitate the opportunity for date rape.

The use of oxytocin as a date rape drug would present a laborious undertaking. Traditional date rape drugs remain in the body for extended periods of time after a single dosage. A single dosage of rohypnol, for example, could produce effects for four to six hours. Unlike these drugs, oxytocin has a very short life span in the body, roughly 3-10 minutes. Therefore, the supply of oxytocin would have to be sustained in significant quantities in order to produce effective potential as a date rape drug. Given the amount of work this would entail, perpetrators are more likely to stick with the convenience presented by tried and true drugs such as ketamine, rohypnol and alcohol.

---

[319] RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet.

[320] Vishwajeet, Singh and Aneesh Srivastava. "Water Intoxication Leading to Hyponatremia and Seizures: A Rare Complication of Uroflowmetry." *International Urology and Nephrology* 47, no. 2 (June 2005), 275.

[321] RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet.

[322] Goldberg, Carey. "Feeling Shy, Afraid of Strangers? Hormone Under Study May Help" [article on-line]. Boston, MA: Boston Globe, 2005, accessed 9 November 2007; available from http://www.boston.com/yourlife/health/mental/articles/2005/12/26/feeling_shy_afraid_of_strangers_hormone_under_study_may_help/; Internet.

## H. TEAR GAS, TOXINS AND TASERS

Despite considerations of physical discomfort or injury, some methods are commonly used in law enforcement and military scenarios. Riot control agents and behavior modification devices such as tear gas and tasers are commonly deployed to stem violence. Riot control agents refer to "any chemical not listed in a Schedule, which can produce rapidly in human sensory irritation or disabling physical effects which disappear within a short time following termination of exposure."[323] In other words, riot control agents are not governed by international treaties such as the Nuremburg Code, Helsinki Document or Biological Weapons Conference. If used solely in a law enforcement context, oxytocin could escape governance by such international agreements; though, agents used in law enforcement contexts must still be declared under the Chemical Weapons Conference.[324]

Tasers and tear gas have been deemed acceptable measure to curb unnecessary violence in a non-lethal, though sometimes injurious, manner. Taser and tear gas utilization are rarely contested by the general public. The underlying assumption is that these devices benefit society to a greater extent than they infringe on civil and human rights—this, obviously, is a utilitarian perspective. With equal understanding of the intent and purpose of oxytocin administration, the general public may accept the risks of oxytocin techniques in the same utilitarian perspective. Given that oxytocin is routinely administered to pregnant women during childbirth, it is very plausible that the general public would view oxytocin as an innocuous law enforcement tactic allowing first responders to better serve and protect communities. It is significant to note that oxytocin is a Federal Drug Administration approved biological compound that is routinely administered. The techniques described in this thesis are merely "off the label" uses.

---

[323] Organization for the Prohibition of Chemical Weapons. "Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction" [article on-line]. NYC: United Nations, 2007, accessed 10 November 2007; available from http://www.opcw.org/html/db/cwc/eng/cwc_article_II.html; Internet.

[324] Chemical and Biological Weapons Nonproliferation Program. "The Moscow Theater Hostage Crisis: Incapacitants and Chemical Warfare" [article on-line]. Monterey, CA: James Martin Center for Nonproliferation Studies, 2002, accessed 13 October 2007; available from http://cns.miis.edu/pubs/week/02110b.htm; Internet.

## I. CONCLUSION

The topics discussed in this chapter demonstrate that the use of chemicals in a general setting carries significant social, ethical and legal consequences. There is no simple, straightforward answer to whether oxytocin usage in law enforcement and military scenarios is right or wrong. If usage is viewed at utilitarian or altruistic for the benefit of society as a whole, then oxytocin's usage in law enforcement and military scenarios is more likely to be viewed as positive. Regardless of intentions, it is vital that careful safety measures are exercised to ensure minimal risk of death due to oxytocin exposure in any scenario.

The next chapter discusses the conclusions of this thesis and provides recommendations based on the data presented throughout this effort. Additionally, limitations of this research effort will be reviewed, and future research opportunities related to this study will be explored.

THIS PAGE INTENTIONALLY LEFT BLANK.

# VI. CONCLUSION

This chapter presents the results of this thesis and recommendations based on those results. Of course, once one question is answered, the answer tends to lead only to additional questions. Consequently, a summary of potential future research topics uncovered during this research effort is also provided.

## A. ANALYSIS

This thesis sought to answer the overall research question: Does the hormone oxytocin provide potentially valuable law enforcement and/or military applications? Three hypotheses were posited to explore the overall research question. This section reviews the three hypotheses presented in Chapter I followed by evaluations of each hypothesis based on the data collected within the previous chapters.

Hypothesis #1: Feasibly practical applications for oxytocin exist within the law enforcement and military fields. Based on the data reviewed within this document, the answer to this question appears to be that oxytocin could provide potentially valuable law enforcement applications; however, due to international laws and treaties, oxytocin applications may not be suitable for specific military actions. Therefore, military applications may be constrained to the same applications as available to law enforcement, though substantial technical and operational challenges need to be resolved first. Potential law enforcement scenarios that could potentially benefit from the use of oxytocin include interviewing child witnesses/victims, enhancing trust relationships between first responders and suicide-attempt victims, hostage crisis resolution, infiltration, riot control and inmate rehabilitation.

Hypothesis #2: Oxytocin reduces the amount of time necessary to build effective trust relationships. Due to a lack of empirical evidence, this hypothesis is difficult to confirm or disprove. Available evidence suggests that oxytocin does reduce the amount of time necessary to build effective trust relationships; however, further experimental research is necessary to determine the extent to which this assessment is true or not true. This factor is essential to the time-sensitive nature of many scenarios explored in this

thesis, especially in building trust relationships with suicide-attempt victims and members of organizations targeted for infiltration.

Hypothesis #3: Oxytocin contributes to both trusting and acting on trust. As noted in Chapter I, trusting and acting on trust are entirely different actions. Data from existing sources indicates that oxytocin contributes to both trusting and acting on trust. Data from experiments on human subjects has shown that individuals exposed to oxytocin are more inclined to trust and act on that trust.[325] Independently-conducted studies demonstrate that subjects exposed to oxytocin are more likely to extend trust, even when there is evidence to the contrary, and to act on that trust by surrendering money to other individuals in the experiment's scenario.

In addition to enhancing trust, oxytocin increases one's readiness to engage in social situations and enhances one's ability to infer the emotional states of others. These additional effects of oxytocin can also provide significant benefits to law enforcement and military personnel. Successful resolution of many law enforcement and military scenarios depends on the willingness of victims and perpetrators to engage with law enforcement and military personnel responding to the situation. If individuals involved in the situation are more willing to socially engage, the potential for successfully and peacefully resolving the situation increases significantly.

Additionally, oxytocin's ability to enhance the ability to infer emotional states can be significantly beneficial. In laboratory experiments, individuals with impaired abilities to perceive the emotional states of others demonstrated significant empathic improvement

---

[325] M. Kosfeld, M. Heinrichs, P. Zak, U. Fischbacher and E. Fehr. "Oxytocin Increases Trust in Humans." *Nature* 435 (2005):673-676; P. Kirsch, C. Esslinger, Q. Chen, D. Mier, S. Lis, S. Siddhanti, H. Gruppe, V. S. Mattay, B. Gallhoffer and A. Meyer-Lindenberg. "Oxytocin Modulates Neural Circuitry for Social Cognition and Fear in Humans." *Journal of Neuroscience* 25 (December 2005):11489-93; Keith M. Kendrick. "The Neurobiology of Social Bonds" [article on-line]. London: British Society for Neuroendocrinology, 2006, accessed 13 October 2007; available from http://neuroendo.org.uk/index.php/content/view/34/11/; Internet; M. R. Thompson,. P. D. Callaghan, G. E. Hunt, J. L. Cornish, I. S. McGregor. "A role for oxytocin and 5-HT(1A) receptors in the prosocial effects of 3,4 methylenedioxymethamphetamine ("ecstasy")." *Neuroscience* 146 (March 2007):509-14; H.K. Caldwell and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006; Lim Xuan-shi. "A Closer Look at the Familiar: What Do We Know About Trust?" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 27 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro05/web3/xlim.html; Internet.

when exposed to oxytocin.[326] This was especially true when discerning emotional states such as fear, anger and disgust.[327] The benefits of this effect are most significant in scenarios such as hostage crises, where hostage-takers exposed to oxytocin might be able to read the fear in their victims' faces and engender empathy with those victims.

## B. RECOMMENDATIONS

As discussed above, law enforcement and military organizations could derive beneficial effects from oxytocin applications in the context of interviewing child witnesses/victims, responding to suicide-attempt victims, hostage crisis resolution, infiltration, riot control and inmate rehabilitation. Use of oxytocin outside national borders would most likely be viewed on the international stage as a chemical/biological attack on a foreign population. Therefore, the use of oxytocin to quell insurgencies is an unlikely application based on legal constraints.

Additionally, it should be noted that oxytocin should be used in conjunction with established response procedures and should not be relied upon as a substitute for those procedures. The roles of the first responder, hostage negotiator, social worker and military personnel involve many successful response techniques for all the scenarios discussed in this thesis. Oxytocin cannot replace these techniques. Instead, the intended point of this thesis is to provide a tool to enhance the effectiveness of established law enforcement and military techniques that have proven themselves successful.

## C. FUTURE RESEARCH

As noted earlier, several follow-on research opportunities related to oxytocin applications have been uncovered during this research effort. While this thesis intended to demonstrate the potential benefits of oxytocin within the law enforcement and military realms, significant data points require further research to determine the extent to which

---

[326] Domes, Gregor, Markus Heinrichs, Andre Michel, Christoph Berger and Sabine C. Herpertz. "Oxytocin Improves Mind-Reading in Humans." *Biological Psychiatry* 10, no. 1016 (15 July 2006); Jennifer A. Bartz and Eric Hollander. "Is Oxytocin the Key to Understanding?" [article on-line]. NYC: *Scientific American*, 2007, accessed 27 October 2007; available from http://blog.sciam.com/index.php?title=the_hormone_that_helps_you_read_minds&more=1&c=1&tb=1&pb=1; Internet.

[327] Ibid.

oxytocin can deliver on the hypotheses suggested in this thesis. Before oxytocin can be integrated into procedures, several research questions must be answered:

- Does oxytocin affect trust when absorbed through the skin?
- Does the vagus nerve provide an effective path for blood-borne oxytocin to affect trust-building?
- How does oxytocin affect fear?
- How does oxytocin affect aggression?
- Can oxytocin increase a schizophrenic's readiness to engage in social situations?
- How does the American public perceive oxytocin applications in law enforcement and military procedures: a benefit to public safety or an infringement on civil/human rights?

Before integrating oxytocin into established response procedures, it is highly recommended that additional research be pursued to determine specific oxytocin effect levels on trust and other emotions (fear, anxiety, aggression, etc), optimally effective dispersal/administration techniques and adequate safety standards. If oxytocin continues to promise potential benefits after this additional research, explicit guidelines for appropriate usage must be determined. This guidance should also establish situations in which oxytocin usage is not appropriate, such as when oxytocin administration would endanger premature contractions in an expectant mother.

Additionally, research projects would need to determine oxytocin's effectiveness in specific law enforcement and military scenarios. Given that trust decisions are affected by specific scenarios, oxytocin may work effectively in some scenarios and not in others, depending specifically on behavioral, physiological and sociological conditions. Finally, while several administration techniques were suggested in this thesis (such as via humidifier or through a building's ventilation system), these administration techniques must be scrutinized. When oxytocin is to be administered covertly, the scent of oxytocin must be undetectable by the human olfactory senses. Experiments may yield more effective administration techniques that the ones suggested in this document.

## D. LIMITATIONS

Every research initiative must deal with limitations, and this research effort was no exception to that rule. A lack of empirical data is an inherent limitation while exploring original topics. Although oxytocin research is beginning to branch out into previously unexplored areas (such as oxytocin's influence on trust and autism), there remains little empirical data to ground several assumptions in Chapter IV. However, the silver lining to an innovative approach is that many new avenues for research are uncovered with the potential for significant benefits if follow-on research confirms the assumptions in this thesis. As stated from the beginning of this research effort, the overall goal was to provide ideas for potentially beneficial law enforcement and military uses for oxytocin. Despite the significant limitation of existing empirical data, this goal was achieved.

However, this thesis also discovered three potential limitations of working with oxytocin in social situations. First, an effective single dosage yields a short window of opportunity for first responders. A single dosage may only yield three to ten minutes of influence. This limitation can be countered by methods that continuously maintain effective exposure to oxytocin via environmental controls; however, it is crucial to maintain safe levels of exposure given oxytocin's ability to cause water intoxication.

The second potential limitation of working with oxytocin in social situations develops from administration techniques. Some situations are inherently more controllable than other. For example, when interviewing a witness, law enforcement personnel can manipulate variables more easily than they can when faced with a hostage crisis situation. Administration techniques are limited by the amount of control law enforcement and military personnel have over situational variables. Some situations encountered by law enforcement and military personnel may not be compatible with oxytocin usage due to constraints on the ability to administer oxytocin effectively or on the ability to maintain oxytocin exposure within safe limits.

Finally, as discussed in Chapter V, social factors may provide significant limitations to oxytocin applications. Social limitations include negative public opinion and legality toward oxytocin usage. Public opinion is significantly influenced by

perceptions of harm, perceptions of infringement on civil/human rights and perceptions of the true intentions of the agencies that utilize psychoactive chemicals. Oxytocin usage in law enforcement and military applications is subject to many laws and treaties such as the Nuremburg Code, Helsinki Document, Biological Weapons Conference and Chemical Weapons Conference. Both public opinion and legal constraints will significantly impact development of oxytocin for specific applications outside of the medical field.

## E. FINAL WORDS

Hormones and chemicals can have significant effects on human behavior. Hormones can calm us down, exhilarate us or inspire aggression. Likewise, chemicals can produce feelings of extreme ecstasy or intense pain. The average individual is exposed to numerous hormones and chemicals via a myriad of methods each day—from the peptides in your energy drink to the caffeine in your coffee. Hormonal effects can be elicited indirectly as well, such as from effective advertising campaigns or spirited speech-making. The chemicals within affect us deeply—more so than we might like to believe. With our burgeoning understanding of how intrinsically the human organism is affected by these chemicals, the possibility for developing tools to help protect individuals from the onslaught of society becomes more material.

# LIST OF REFERENCES


Abraham, Kera. "Flying Right at the Issue: Disclosure of Moth Pheromone Product's Inert Ingredients Incites a Legal Battle" [article on-line]. Monterey, CA: Monterey County Weekly, 2007, accessed 7 November 2007; available from http://www.mcweekly.com/issues/Issue.10-18-2007/news/Article.news_2; Internet.

Aleman, Andre, Edward H. F. de Haan, Stacy A. Castner, Graham V. Williams and Patricia S. Goldman-Rakic. "Antipsychotics and Working Memory in Schizophrenia." *Science* 289, no. 5476 (7 July 2000): 56-58.

Antelman, Seymour M. and Anthony R. Caggiula. "Norepinephrine-Dopamine Interactions and Behavior." *Science* 195, no. 4279 (18 February 1979): 646-653.

Axelrod, Julius and Terry D. Reisine. "Stress Hormones: Their Interaction and Regulation." *Science* 224, no. 4648 (4 May 1984): 452-459.

Bandler, Richard J., Jr, and John P. Flynn. "Neural Pathways from Thalamus Associated with Regulation of Aggressive Behavior." *Science* 183, no. 4120 (11 January 1974): 96-99.

Barbassa, Juliana. "Judge Says Pesticide Spraying Can Resume on Calif's Central Coast" [article on-line] Monterey, CA: The Monterey Herald, 2007, accessed 14 November 2007; available from http://www.montereyherald.com/search/ci_7227387?IADID=Search-www.montereyherald.com-www.montereyherald.com; Internet.

Barchas, Jack D., Huda Akil, Glen R. Elliot, R. Bruce Holman and Stanley J. Watson. "Behavioral Neurochemistry: Neuroregulators and Behavioral States." Science 200, no. 4344 (26 May 1978): 964-973.

Barinaga, Marcia. "How Scary Things Get That Way." *Science* 258, no. 5084 (6 November 1992): 887-888.

Bartz, Jennifer A. and Eric Hollander. "Is Oxytocin the Key to Understanding?" [article on-line]. NYC: Scientific American, 2007, accessed 27 October 2007; available from http://blog.sciam.com/index.php?title=the_hormone_that_helps_you_read_minds&more=1&c=1&tb=1&pb=1; Internet.

Bechara, Antoine, Daniel Tranel, Hanna Damasio, Ralph Adolphs, Charles Rockland, Antonio R. Damasio. "Double Dissociation of Conditioning and Declarative Knowledge Relative to the Amygdala and Hippocampus in Humans." *Science* 269, no. 5227 (25 August 1995): 1115-1118.

Becker, Lawrence C. "Trust as Non-cognitive Security About Motives" [article on-line]. Chicago, IL: University of Chicago Press, 1996, accessed 22 August 2007; available from http://www.jstor.org/view/00141704/di994964/ 99p00905/0; Internet.

Bennetto, Loisa, Bruce F. Pennington and Sally J. Rogers. "Intact and Impaired Memory Functions in Autism." *Child Development* 67, no. 4 (August 1996): 1816-1835.

Bergland, Richard M. and Robert B. Page. "Pituitary-Brain Vascular Relations: A New Paradigm." *Science* 204, no. 4388 (6 April 1979): 18-24.

Best, Ben. "Chapter 7: Brain Areas Supporting Cerebral Cortex Function" [article on-line]. Clinton Township, MI: Cryonics Institute, 2007, accessed 21 October 2007; available from http://www.benbest.com/science/anatmind/anatmd7.html; Internet.

Best, Mary, J. Michael Williams and Emil F. Coccaro. "Evidence for a Dysfunctional Prefrontal Circuit in Patients with an Impulsive Aggressive Disorder." *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 12 (11 June 2002): 8448-8453.

Bisset, G. W., S. M. Hilton and A. M. Poisner. "Hypothalamic Pathways for Independent Release of Vasopressin and Oxytocin." *Proceedings of the Royal Society of London. Series B, Biological Sciences* 166, no. 1005 (24 January 1967): 422-442.

Black, Harvey. "Amygdala's Inner Workings." *The Scientist* 15, no. 19 (1 October 2001): 20-24.

Black, Kevin, Tamara Hershey, Jonathan M. Koller, Tom O. Videen, Mark A. Mintun, Joseph L. Price and Joel S. Perlmutter. "A Possible Substrate for Dopamine-Related Changes in Mood and Behavior: Prefrontal and Limbic Effects of a D3-Preferring Dopamine Agonist." *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 26 (24 December 2002): 17113-17118.

*Boston Globe*. "To Sniff at Danger." [article on-line]. Boston: *Boston Globe*, 2006, accessed 13 October 2007; available from http://www.smh.com.au/news/mind-matters/to-sniff-at-danger/2006/01/12/1136956247384.html; Internet.

Brady, Janine, Jason Carroll, Laura Dolan and Leslie Wiggin. "Report: China halts export of bead toys tainted with toxic drug" [article on-line]. Atlanta, GA: CNN, 2007, accessed 9 November 2007; available from http://www.cnn.com/2007/WORLD/asiapcf/11/09/toy.recall/index.html; Internet

Brain Injury Resource Foundation. "Scan Shows if People Trust You." [article on-line]. Atlanta, GA: Brain Injury Resource Foundation, 2007, accessed 27 October 2007; available from http://www.birf.info/home/whats-new/international/trust-scan.html; Internet.

Bransten, Jeremy. "US: Pentagon Unveils the Next Generation of Nonlethal Weapons" [article on-line]. Alexandria, VA: globalsecurity.org, 2007, accessed 9 November 2007; available from http://www.globalsecurity.org/military/library/news/2007/01/mil-070130-rferl02.htm; Internet.

Brekke, J. S., C. Prindle, S. W. Bae and J. D. Long. "Risks for Individuals with Schizophrenia Who Are Living in the Community." *Psychiatric Service* 52, no. 10 (October 2001): 1358-1366.

Brown, David. "Study Claims Iraq's 'Excess' Death Toll Has Reached 655,000" [article on-line]. Washington, DC: Washington Post, 2006, accessed 6 November 2007; available from http://www.washingtonpost.com/wp-dyn/content/article/2006/10/10/AR2006101001442.html; Internet.

Brownstein, Michael J., James T. Russell and Harold Gainer. "Synthesis, Transport and Release of Posterior Pituitary Hormones." *Science* 207, no. 4429 (25 January 1980): 373-378.

Bureau of International Security and Nonproliferation. "Convention of the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction" [article on-line]. Washington, DC: Department of State, 2007, accessed 13 October 2007; available from http://www.state.gov/t/ac/trt/4718.htm; Internet.

Buskens, Vincent and Werner Raub. "Embedded Trust: Control and Learning." In *Group Cohesion, Trust and Solidarity*, ed. Shane R. Thye and Edward J. Lawler, 167-202. Oxford, UK: Elsevier Science Ltd, 2002.

Caldwell, H.K. and W.S. Young, III. "Oxytocin and Vasopressin: Genetics and Behavioral Implications." In *Handbook of Neurochemistry and Molecular Neurobiology, 3rd ed.*, ed. R. Lim, 573-607. Springer, New York, 2006.

Capra, C. Monica. "Mood-Driven Behavior in Strategic Interactions." *The American Economic Review* 94, no. 2 (May 2004): 367-372.

Caruthers, R., A. K. Mueller, H. F. Muller and P. Gloor. "Interaction of Evoked Potentials of Neocortical and Hypothalamic Origin in the Amygdala." *Science* 144, no. 3617 (24 April 1964): 422-423.

Cases, Olivier, Isabelle Seif, Joseph Grimsby, Patricia Gaspar, Kevin Chen, Sandrine Pournin, Ulrike Mueller, Michel Aguet, Charles Babinet, Jean Chen Shih and Edward De Maeyer. "Aggressive Behavior and Altered Amounts of Brain Serotonin and Norepinephrine in Mice Lacking MAOA." *Science* 268, no. 5218 (23 June 1995): 1763-1766.

Castelfranchi, Cristiano and Rino Falcone. "Principles of Trust for MAS: Cognitive Anatomy, Social Importance and Quantification" [article on-line]. Rome, Italy: National Research Council, 1999, accessed 22 August 2007; available from http://aois.org/99/castelfranchi-ICMAS-paper.rtf; Internet.

Centers for Disease Control. "The Benefits of Fluoride" [article on-line]. Atlanta, GA: Centers for Disease Control, 2005, accessed 9 November 2007; available from http://www.cdc.gov/fluoridation/fact_sheets/benefits.htm; Internet.

Centers for Disease Control. "Facts About Riot Control Agents" [article on-line]. Atlanta, GA: Centers for Disease Control, 2003, accessed 5 November 2007; available from http://emergency.cdc.gov/agent/riotcontrol/factsheet.asp; Internet.

Chao, Elaine L. "From Hard Time to Full Time" [article on-line]. Washington, DC: U.S. Department of Labor, 2001, accessed 5 November 2007; available from http://www.hirenetwork.org/pdfs/From_Hard_Time_to_Full_Time.pdf; Internet.

Chemical and Biological Weapons Nonproliferation Program. "The Moscow Theater Hostage Crisis: Incapacitants and Chemical Warfare" [article on-line]. Monterey, CA: James Martin Center for Nonproliferation Studies, 2002, accessed 13 October 2007; available from http://cns.miis.edu/pubs/week/02110b.htm; Internet.

Cherniss, Cary. "Emotional Intelligence: What It Is and Why It Matters" [article on-line]. Piscataway, NJ: Rutgers University, 2000, accessed 22 August 2007; available from http://www.eiconsortium.org/research/what_is_emotional_ intelligence.htm; Internet.

Cohen, Jon. "Does Nature Drive Nurture?" *Science* 273, no. 5275 (2 August 1996): 577-578.

Committee on Veteran's Affairs. "Is Military Research Hazardous to Veterans' Health? Lessons Spanning Half a Century" [report on-line]. Washington, DC: United States Senate, 1994, accessed 14 November 2007; available from http://www.gulfweb.org/bigdoc/rockrep.cfm#hallucinogens; Internet.

Cook, Karen S. and Robin M. Cooper. "Experimental Studies of Cooperation, Trust and Social Exchange." In *Trust and Reciprocity*, ed. Elinor Ostrom and James Walker, 209-243. NYC: Russell Sage Foundation, 2003.

Cook, Karen S., Russell Hardin and Margaret Levi. *Cooperation Without Trust?* NYC: Russell Sage Foundation, 2005.

Coon, Charlie. "Troops Learn Non-Lethal Crowd-Control Techniques" [article on-line]. Boeblingen, Germany: Stars and Stripes, 2006, accessed 5 November 2007; available from https://www.jnlwp.com/Resources/Articles/NonlethalCrowdControl.pdf; Internet.

Darling, David. "Hypothalamus" [article on-line]. NYC: Encyclopedia of Science, 2007, accessed 21 October 2007; available from http://www.daviddarling.info/encyclopedia/H/hypothalamus.html; Internet.

Date, Yukari, Yoichi Ueta, Hiroshi Yamashita, Hideki Yamaguchi, Shigeru Matsakura, Kenji Kangawa, Takeshi Sakurai, Masashi Yanagisawa and Masamitsu Nakazato. "Orexins, Orexigenic Hypothalamic Peptides, Interact with Autonomic, Neuroendocrine and Neuroregulatory Systems." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 2 (19 January 1999): 748-753.

Davidson, Richard J., Jeffrey S. Maxwell and Alexander J. Shackman. "The Privileged Status of Emotion in the Brain." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 33 (17 August 2004): 11915-11916.

Davidson, Richard J., Katharine M. Putnam and Christine L. Larson. "Dysfunction in the Neural Circuitry of Emotion Regulation: A Possible Prelude to Violence." *Science* 289, no. 5479 (28 July 2000): 591-584.

Davies, James C. "Violence and Aggression: Innate or Not?" *The Western Political Quarterly* 23, no. 3 (September 1970): 611-623.

Davis, Michael, David L. Walker and Younglim Lee. "Amygdala and Bed Nucleus of the Stria Terminalis: Differenctial Roles in Fear and Anxiety Measured with the Acoustic Startle Reflex." *Philosophical Transactions: Biological Sciences* 352, no. 1362 (29 November 1997): 1675-1687.

De Wied, D. "Behavioural Actions of Neurohypophysial Peptides." *Proceedings of the Royal Society of London. Series B, Biological Sciences* 210, no. 1178 (29 October 1980): 183-194.

Defense Oversight Group. "Results of the 1973 Church Committee Hearings on CIA Misdeeds and the 1984 Iran Contra Hearings" [article on-line]. Washington, DC: Civil Intelligence Association, 2007, accessed 9 November 2007; available from http://pw1.netcom.com/~ncoic/cia_info.htm#Table%20of%20Contents; Internet.

Denning, Dorothy, Naval Postgraduate School instructor, interview by author, 14 November 2007, in person.

Di Franza, J. R., J. W. Richards, P. M. Paulman, N. Wolf-Gillespie, C. Fletcher, R. D. Jaffe and D. Murray. "RJR Nabisco's Cartoon Camel Promotes Camel Cigarettes to Children." *Journal of the American Medical Association* 268, no. 15 (21 October 1992): 2034.

Dietrichs, Espen. "Cerebellar Autonomic Function: Direct Hypothalamocerebellar Pathway." *Science* 223, no.4636 (10 February 1984): 591-593.

Domes, Gregor, Markus Heinrichs, Andre Michel, Christoph Berger and Sabine C. Herpertz. "Oxytocin Improves Mind-Reading in Humans." *Biological Psychiatry* 10, no. 1016 (15 July 2006): 731-733.

Earle, Timothy and George T. Cvetkovich. *Social Trust: Toward a Cosmopolitan Society*. NYC: Praeger Publishing, 1995.

Ebner, Karl, Nadia M. Rupniak, Alois Saria, Nicolas Singewald and Tomas Hoekfelt. "Substance P in the Medial Amygdala: Emotional Stress-Sensitive Release and Modulation of Anxiety-Related Behavior in Rats." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 12 (23 March 2004): 4280-4285.

*Economist*. "I Get a Kick out of You: Scientists Are Finding that, After All, Love Really Is Down to a Chemical Addiction Between People." [article on-line.] London: *The Economist*, 2004, accessed 13 October 2007; available from http://www.oxytocin.org/oxytoc/love-science.html; Internet.

Egger, M. David and John P. Flynn. "Amygdaloid Suppression of Hypothalamically Elicited Attack Behavior." *Science* 136, no. 3510 (6 April 1962): 43-44.

Ferris, C. F., H. E. Albers, S. M. Wesolowski, B. D. Goldman and S. E. Luman. "Vasopressin Injected into the Hypothalamus Triggers a Stereotypic Behavior in Golden Hamsters." *Science* 224, no. 4648 (4 May 1984): 521-523.

Fields, H. L. and Mary M. Heinricher. "Anatomy and Physiology of a Nociceptive Modulatory System." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 308, no. 1136 (19 February 1985): 361-374.

Fischer, P. M., M. P. Schwartz, J. W. Richards, Jr., A. O. Goldstein and T. H. Rojas. "Brand Logo Recognition by Children Aged 3 to 6 Years. Mickey Mouse and Old Joe the Camel." *Journal of the American Medical Association* 266, no. 22 (11 December 1991): 3185-3186.

Fitzgerald, P. B., A. R. de Castella, K. M. Filia, S. L. Filia, J. Benitez and J. Kulkarni. "Victimization of Patients with Schizophrenia and Related Disorders." *Australia/New Zealand Journal of Psychiatry* 39, no. 3 (March 2005): 169-174.

Freeman, D. and P.A Garety. *Paranoia: The Psychology of Persecutory Delusions*. Hove: Psychology Press, 2004.

Gambetta, Diego. "Can We Trust Trust?" In *Trust: Making and Breaking Cooperative Relationships*, ed. Diego Gambetta, 213-237. Oxford: Basil Blackwell, 1988

George, Jack M. "Vasopressin and Oxytocin are Depleted from Rat Hypothalamic Nuclei After Oral Hypertonic Saline." *Science* 193, no. 4248 (9 July 1976): 146-148.

Gessner, B. D., M. Beller, J. P. Middaugh and G. M. Whitford. "Acute Fluoride Poisoning From a Public Water System." *New England Journal of Medicine* 330, no. 2 (13 January 1994): 95-99.

Glaesser, Edward L., David I. Laibson, Jose A. Scheinkman and Christine L. Soutter. "Measuring Trust" [article on-line]. Cambridge, MA: MIT Press, 2000, accessed 22 August 2007; available from http://www.jstor.org/view/00335533/di011633/01p0133c/0; Internet.

Goldberg, Carey. "Feeling Shy, Afraid of Strangers? Hormone Under Study May Help" [article on-line]. Boston, MA: Boston Globe, 2005, accessed 9 November 2007; available from http://www.boston.com/yourlife/health/mental/articles/2005/12/26/feeling_shy_afraid_of_strangers_hormone_under_study_may_help/; Internet.

Gottschalk, Louis A., Walter N. Stone, Goldine C. Gleser and James M. Iacono. "Anxiety Levels in Dreams: Relation to Changes in Plasma Free Fatty Acids." *Science* 153, no. 3736 (5 August 1966): 654-657.

Gray, Henry. "The Fore-Brain or Prosencephalon" [article on-line]. NYC: Bartleby.com, 2005, accessed 21 October 2007; available from http://www.bartleby.com/107/189.html; Internet.

Grewen, Karen M., Susan S. Girdler, Janet Amico and Kathleen C. Light. "Effects of Partner Support on Resting Oxytocin, Cortisol, Norepinephrine, and Blood Pressure Before and After Warm Partner Contact." *Psychosomatic Medicine* 67 (October 2005): 531-538.

Haines, Lester. "Piranhas actually scaredycats, boffins claim" [article on-line]. London: Situation Publishing Ltd., 2007, accessed 9 September 2007; available from http://www.theregister.co.uk/2007/07/02/piranha_legend_debunked/; Internet.

Harbaugh, William T., Kate Krause, Steven G. Liday Jr. and Lise Vesterlund. "Trust in Children." In *Trust and Reciprocity*, ed. Elinor Ostrom and James Walker, 302-322. NYC: Russell Sage Foundation, 2003.

Hardin, Russell. *Trust and Trustworthiness*. NYC: Russell Sage Foundation, 2002.

Heinrichs, M., T. Baumgartner, C. Kirschbaum, and U. Ehlert. "Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress." *Biological Psychiatry*, 54 (July 2003): 1389-1398.

Hoebel, Bartley G. and Philip Teitelbaum. "Hypothalamic Control of Feeding and Self-Stimulation." *Science* 135, no. 3501 (2 February 1962): 375-377.

Hoffman R., J. Mann, J. Calderone, J. Trumbull and M. Burkhart. "Acute Fluoride Poisoning in a New Mexico Elementary School." *Pediatrics* 65, no. 5 (May 1980): 897-900.

Hollander, E., J. Bartz and W. Chaplin. "Oxytocin increases retention of social cognition in autism". *Biological Psychiatry* 61, no. 4 (2007): 498–503.

Holt, Doug. "The Role of the Amygdala in Fear and Panic" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 19 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro98/202s98-paper2/Holt2.html; Internet.

Horton, James L., "Trust, Reason and Relations" [article on-line]. NYC: Millican, Marston and Associates, 2004, accessed 22 August 2007; available from http://www.online-pr.com/Holding/Trust_Reason_and_Relations__REVISED.pdf; Internet.

Huber, Robert, Kalim Smith, Antonia Delago, Karin Isaksson and Edward A. Kravitz. "Serotonin and Aggressive Motivation in Crustaceans: Altering the Decision to Retreat." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 11 (27 May 1997): 5939-5942.

Hunt, Alan. "Anxiety and Social Explanation: Some Anxieties about Anxiety." *Journal of Social History* 32, no. 3 (Spring 1999): 509-528.

Insel, Thomas R. and Lawrence E. Shapiro. "Oxytocin Receptor Distribution Reflects Social Organization in Monogamous and Polygamous Voles." *Proceedings of the National Academy of Sciences of the United States of America* 89, no. 13 (1 July 1992): 5981-5985.

Iowa State University. "The Science of Smell Part 2: Odor Chemistry" [article on-line]. Ames, IA: Iowa State University, 2004, accessed 4 November 2007; available from http://www.extension.iastate.edu/Publications/PM1963B.pdf; Internet.

Iraq Body Count. "Iraq Body Count" [article on-line]. Washington, DC: Iraq Body Count, 2007, accessed 6 November 2007; available from http://www.iraqbodycount.org/; Internet.

Isenberg, N., D. Silbersweig, A. Engelien, S. Emmerich, K. Malavade, B. Beattie, A. C. Leon and E. Stern. "Linguistic Threat Activates the Human Amygdala." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 18 (31 August 1999): 10456-10459.

Iverson, Leslie L. "Dopamine Receptors in the Brain." *Science* 188, no. 4193 (13 June 1975): 1084-1089.

Kantor, Martin. *Understanding Paranoia: A Guide for Professionals, Families, and Sufferers*. Westport: Praeger Press, 2004.

Karl, Tim, Shu Lin, Christoph Schwarzer, Amanda Sainsbury, Michelle Couzens, Walter Wittmann, Dana Boey, Stephan von Hoersten, Herbert Herzog and Tomas Hoekfelt. "Y1 Receptors Regulate Aggressive Behavior by Modulating Serotonin Pathways." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 34 (24 August 2004): 12742-12747.

Karon, Tony. "Behind the Moscow Theater Siege" [article on-line]. NYC: Time Magazine, 2002, accessed 13 October 2007; available from http://www.time.com/time/world/article/0,8599,383909,00.html; Internet.

KCBA. "Light Brown Apple Moth Meeting in Monterey" [article on-line]. Monterey, CA: KCBA, 2007, accessed 9 November 2007; available from http://www.kcba.com/news/local/story.aspx?content_id=eab0255e-63fe-4e40-8c26-d6a18e753fb9; Internet.

Kendrick, Keith M. "The Neurobiology of Social Bonds" [article on-line]. London: British Society for Neuroendocrinology, 2006, accessed 13 October 2007; available from http://neuroendo.org.uk/index.php/content/view/34/11/; Internet.

Kim, Jeansok K. and Michael S. Fanselow. "Modality-Specific Retrograde Amnesia of Fear." *Science* 256, no. 5057 (1 May 1992): 675-677.

Kimball, Daryl. "The Chemical Weapons Convention at a Glance" [article on-line]. Washington DC: Arms Control Association, 2007, accessed 14 November 2007; available from http://www.armscontrol.org/factsheets/cwcglance.asp?print; Internet.

Kirsch, P, C. Esslinger, Q. Chen, D. Mier, S. Lis, S. Siddhanti, H. Gruppe, V. S. Mattay, B. Gallhoffer and A. Meyer-Lindenberg. "Oxytocin Modulates Neural Circuitry for Social Cognition and Fear in Humans." *Journal of Neuroscience* 25 (December 2005):11489-93.

Komisaruk, B.R, B. Whipple, A. Crawford, S. Grimes, W-C. Liu, A. Kalin, and K. Mosier. "Brain activation during vaginocervical self-stimulation and orgasm in women with complete spinal cord injury: fMRI evidence of mediation by the Vagus nerves." *Brain Research* 1024 (2004): 77-88.

Kosfeld, M, M. Heinrichs, P. Zak, U. Fischbacher and E. Fehr. "Oxytocin Increases Trust in Humans." *Nature* 435 (2005):673-676

Kovacs, G.L., Z. Sarnyai and G. Szabo. "Oxytocin and Addiction: a Review." *Psychoneuroendocrinology* 23 (1998): 945-962.

Krasne, Franklin B. "General Disruption Resulting from Electrical Stimulus of Ventromedial Hypothalamus." *Science* 138, no. 3542 (16 November 1962): 822-823.

Krieger, Dorothy T. "Brain Peptides: What, Where and Why?" *Science* 222, no. 4627 (2 December 1983): 975-985.

Krisberg, Barry and Susan Marchionna. "Attitudes of US Voters toward Prisoner Rehabilitation and Reentry Policies" [article on-line]. Washington, DC: National Council on Crime and Delinquency, 2006, accessed 5 November 2007; available from http://fwww.famm.org/Repository/Files/Attitudes_of_US_Voters_toward_Prisoner_Rehabilitation_and_Reentry_Policies%5B1%5D.pdf; Internet.

Lancely, Frederick J. "Negotiation Lessons Learned by an FBI Hostage Negotiator." [article on-line] Daytona Beach, FL: Crisis Negotiation Associates, Inc., 2004, accessed 4 November 2007; available from http://www.negotiatormagazine.com/article235_1.html; Internet.

Lee, P. R., D. L. Brady, R. A. Shapiro, D. M. Dorsa and J. I. Koenig. "Social interaction deficits caused by chronic phencyclidine administration are reversed by oxytocin." *Neuropsychopharmacology* 30, no. 10 (October 2005): 1883-1894.

Luhmann, Niklas. "Familiarity, Confidence, Trust: Problems and Alternatives." In *Trust: Making and Breaking Cooperative Relationships*, ed. Diego Gambetta, 94-107. Oxford: Basil Blackwell, 1988.

MacDonald, George. *Unspoken Sermons*. London: Golden Key Publishing, 1867.

Margules, D. L. and J. Olds. "Identical 'Feeding' and 'Rewarding' Systems in the Lateral Hypothalamus of Rats." *Science* 135, no. 3501 (2 February 1962): 374-375.

Martin, John H. *Neuroanatomy: Text and Atlas*. NYC: McGraw-Hill, 2003.

Matthen, Mohan. "Biological Universals and the Nature of Fear." *The Journal of Philosophy* 95, no. 3 (March 1988): 105-132.

McCabe, Kevin A. "A Cognitive Theory of Reciprocal Exchange." In *Trust and Reciprocity*, ed. Elinor Ostrom and James Walker, 147-167. NYC: Russell Sage Foundation, 2003.

McGaugh, James L., Larry Cahill and Benno Roozendaal. "Involvement of the Amygdala in Memory Storage: Interaction with Other Brain Systems." *Proceedings of the National Academy of Sciences of the United States of America* 93, no. 24 (26 November 1996): 13508-13514.

Medical Research Institute of Chemical Defense. "Riot Control Agents" [article on-line]. Aberdeen Proving Ground, MD: United States Army, 1995, accessed 6 November 2007; available from http://www.fas.org/nuke/guide/usa/doctrine/army/mmcch/RiotAgnt.htm; Internet.

Meier, Oliver. "The Biological Weapons Conference at a Glance" [article on-line]. Washington, DC: Arms Control Association, 2006, accessed 13 October 2007; available from http://www.armscontrol.org/pdf/BWCreaderWebVersion.pdf; Internet.

Moberg, Kerstin Uvnas and Roberta Francis. *The Oxytocin Factor: Tapping the Hormone of Love, Calm and Healing*. Cambridge, MA: Da Capo Press, 2003.

Modahl, C., L. Green and D. Fein. "Plasma oxytocin levels in autistic children". *Biological Psychiatry* 43, no. 4 (2007): 270–277.

National Emotional Literacy Project for Prisoners. "Corrections in the US: The Picture Today" [article on-line]. Washington, DC: Lionheart Foundation, 1998, accessed 5 November 2007; available from http://www.lionheart.org/prison_proj/corrections.html; Internet.

Nilsson, L., T. Reinheimer, M. Steinwall and M. Akerlund. "FE 200 440: a selective oxytocin antagonist on the term-pregnant human uterus." *BJOG* 110, no. 11 (November 2003): 1025-1028.

Nooteboom, Bart. *Trust*. Northampton, MA: Edward Elgar Publishing, Inc, 2002.

Office of Defense Nuclear Nonproliferation. "Biological Weapons Convention" [article on-line]. Washington, DC: National Nuclear Security Administration, 2007, accessed 13 October 2007; available from http://www.nnsa.doe.gov/na-20/bwc.shtml; Internet.

Organization for the Prohibition of Chemical Weapons. "Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction" [article on-line]. NYC: United Nations, 2007, accessed 10 November 2007; available from http://www.opcw.org/html/db/cwc/eng/cwc_article_II.html; Internet.

Organization for the Prohibition of Chemical Weapons. "Status of Participation in the Chemical Weapons Convention" [article on-line]. NYC: United Nations, 2007, accessed 14 November 2007; available from http://www.opcw.org/html/db/members_ratifyer.html; Internet.

Park, T. J., C. Comer, A. Carol, Y. Lu, H. S. Hong and F. L. Rice. "Somatosensory organization and behavior in naked mole-rats: II. Peripheral structures, innervation, and selective lack of neuropeptides associated with thermoregulation and pain". *Journal of Comprehensive Neurology* 465, no. 1 (January 2003): 104–120.

Parks, Craig D. and Lorne G. Hulbert. "High and Low Trusters' Responses to Fear in a Payoff Matrix." *The Journal of Conflict Resolution* 39, no. 4 (December 1995): 718-730.

Penman, A. D., P. T. Brackin and R. Embrey. "Outbreak of Acute Fluoride Poisoning Caused by a Fluoride Overfeed, Mississippi 1993." *Public Health Report* 112, no. 5 (September-October 1997): 403-409.

Pfaff, Donald W. "Hormones, Genes and Behavior." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 26 (23 December 1997): 14213-14216.

Plante, Hank. "Pentagon Confirms It Sought to Build a 'Gay Bomb'" [article on-line]. Berkeley, CA: CBS News, 2007, accessed 9 November 2007; available from http://cbs5.com/topstories/local_story_159222541.html; Internet.

Politics.co.uk. "Prison Rehabilitation" [article on-line] London: politics.co.uk, 2007, accessed 4 November 2007; available from http://www.politics.co.uk/issue-briefs/public-services/prisons/prison-rehabilitation/prison-rehabilitation-$366690.htm; Internet.

Pollay, Richard W. "Protecting Children as Consumers: Comments on Proposed Regulations re: Packaging, Marketing, Distribution and Sales of Cigarettes, Etc." [article on-line]. Vancouver, BC: University of British Columbia, 1998, accessed 9 November 2007; available from http://legacy.library.ucsf.edu/tid/ytk22d00/pdf?search=%22protecting%20children%20as%20consumers%20pollay%22; Internet.

Raggenbass, M., M. Dubois-Dauphin, S. Charpak, and J. J. Dreifuss. "Neurons in the Dorsal Motor Nucleus of the Vagus Nerve Are Excited by Oxytocin in the Rat But Not in the Guinea Pig." *Proceedings of the National Academy of Sciences of the United States of America* 84, no. 26 (June 1987): 3926-3930.

Raphael, Dana. "Why Supportive Behavior in Human and Other Animals?" *American Anthropologist* 83, no. 3 (September 1981): 634-638.

Redmond, D. E., Jr., J. W. Maas, A. Kling, C. W. Graham and H. Dekirmenjian. "Social Behavior of Monkeys Selectively Depleted of Monoamines." *Science* 174, no. 4007 (22 October 1971): 428-431.

Reinheimer, Torsten M., Walter H. Bee, John C. Resendez, Julie K. Meyer, George J. Haluska and Garry J. Chellman. "Barusiban, A New Highly Potent and Long Acting Oxytocin Antagonist: Pharmacokinetic and Pharmacodynamic Comparison to Atosiban in a Cynomolgus Monkey Model of Preterm Labor." *The Journal of Clinical Endocrinology and Metabolism* 1210, no. 10 (25 January 2005): 2004-2120.

Rigter, Henk. "Attenuation of Amnesia in Rats by Systemically Administered Enkephalins." *Science* 200, no. 4337 (7 April 1978): 83-85.

Rodgers, Bruce. "Behavioral Aspects of Crowd and Riot Control" [article on-line]. Washington, DC: PoliceLink, 2007, accessed 5 November 2007; available from http://www.policelink.com/training/articles/1828-behavioral-aspects-of-crowd-and-riot-control; Internet.

Ross, Colin A. "BLUEBIRD: Deliberate Creation of Multiple Personality by Psychiatrists" [article on-line]. Berkeley, CA: wanttoknow.info, 2005, accessed 8 November 2007; available from http://www.wanttoknow.info/bluebird10pg; Internet.

RxList. "Pitocin." [article on-line] San Clemente, CA: RxList, Inc, 2007, accessed 13 October 2007, available from http://www.rxlist.com/cgi/generic/oxytocin_ad.htm; Internet.

Saudou, Frederic, Djamel Amara, Andree Dierich, Marianne LeMeur, Sylvie Ramboz, Louis Segu, Marie-Christine Buhot and Rene Hen. "Enhanced Aggressive Behavior in Mice Lacking 5-HT 1B Receptor." *Science* 265, no. 5180 (23 September 1994): 1875-1878.

Schloss, P. and D. C. Williams. "The Serotonin Transporter: A Primary Target for Antidepressant Drugs." *Journal of Psychopharmacology* 12, no. 2 (February 1998): 115-121.

Scott, John W. and Carl Pfaffmann. "Olfactory Input to the Hypothalamus: Electrophysiological Evidence." *Science* 158, no. 3808 (22 December 1967): 1592-1594.

Seeman, Philip and Shitij Kapur. "Schizophrenia: More Dopamine, More D2 Receptors." *Proceedings of the National Academy of Sciences of the United States of America* 97, no. 14 (5 July 2000): 7673-7675.

Senate Committee on Veterans' Affairs. "Is Military Research Hazardous to Veterans' Health? Lessons Spanning Half a Century" [article on-line]. Washington, DC: United States Senate, 1994, accessed 8 November 2007; available from http://www.gulfweb.org/bigdoc/rockrep.cfm#hallucinogens; Internet.

Shusterman, Dennis. "Review of the Upper Airway, Including Olfaction, as Mediator of Symptoms." *Environmental Health Perspectives* 110, no. 4 (August 2002): 649-653.

Smith, Douglas E., Melvyn B, King and Bartley G. Hoebel. "Lateral Hypothalamic Control of Killing: Evidence for a Cholinoceptive Mechanism." *Science* 167, no. 3919 (6 February 1970): 900-901.

Smith, Michael. "Pentagon Planned Love Bomb" [article on-line]. London: Daily Telegraph, 2005, accessed 9 November 2007; available from http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2005/01/15/wlove15.xml &sSheet=/news/2005/01/15/ixnewstop.html; Internet.

Smith, Thomas S. and Gregory T. Stevens. "Hyperstructures and the Biology of Interpersonal Dependence: Rethinking Reciprocity and Altruism." *Sociological Theory* 20, no. 1 (March 2002): 106-130.

Smuts, Barbara. "How Do Other Animals Get Security and Trust?" [article on-line]. San Francisco, CA: Point Foundation, 2002, accessed 22 August 2007; available from http://findarticles.com/p/articles/mi_m0GER/is_2002_Fall/ai_ 93135758/pg_6; Internet.

Sprengelmeyer, Reiner, Andrew W. Young, Ulrike Schroeder, Peter G. Grossenbacher, Jens Federlein, Thomas Buettner and Horst Przuntek. "Knowing No Fear." *Proceeding: Biological Sciences* 266, no. 1437 (22 December 1999): 2451-2456.

Stark, D., S. van Hal, D. Marriott, J. Ellis and J. Harkness. "Irritable bowel syndrome: a review on the role of intestinal protozoa and the importance of their detection and diagnosis". *International Journal of Parasitology* 37, no. 1 (January 2007): 11-20.

Stehle, R. H. "Pressor and Oxytocic Hormones of the Pituitary Gland." *Science* 115, no. 2996 (30 May 1952): 610.

Stellar, Eliot. "Brain Mechanisms in Hunger and other Hedonic Experiences." *Proceedings of the American Philosophical Society* 118, no. 3 (7 June 1974): 276-282.

Stribley, John M. and C. Sue Carter. "Developmental Exposure to Vasopressin Increases Aggression in Adult Prairie Voles." *Proceedings of the National Academy of Sciences of the United States of America* 96, no. 22 (26 October, 1999): 12601-12604.

Suicide Prevention Resource Center. "First Responders" [article on-line]. Newton, MA: Suicide Prevention Resource Center, 2005, accessed 4 November 2007; available from http://www.sprc.org/featured_resources/customized/first_responders.asp; Internet.

Swaab, D. F. and M. A. Hofman. "An Enlarged Suprachiasmatic Nucleus in Homosexual Men." *Brain Research* 537, no. 1-2 (24 December 1990): 141-148.

Sztompka, Piotr. *Trust: A Sociological Theory*. Cambridge, UK: Cambridge University Press, 1999.

Thompson. M. R., P. D. Callaghan, G. E. Hunt, J. L. Cornish, I. S. McGregor. "A role for oxytocin and 5-HT(1A) receptors in the prosocial effects of 3,4 methylenedioxymethamphetamine ("ecstasy")." *Neuroscience* 146 (March 2007):509-14.

Thomson Healthcare, Physicians' Desk Reference (Montvale, NJ: Thomson Healthcare, 2007): MD07645.

TIME. "Riot Control: Hold the Street and Seize the High Ground" [article on-line] NYC: Time Magazine, 1967, accessed 5 November 2007; available from http://www.time.com/time/magazine/article/0,9171,837151,00.html; Internet.

Tops, Mattie, Jacobien M. van Peer, Jakob Korf, Albertus A. Wijers and Don M. Tucker. "Anxiety, Cortisol and Attachment Predict Plasma Oxytocin." Psychophysiology 44, no. 3 (May 2007): 444-449.

Tyler, Tom R. "Why Do People Rely on Others? Social Identity and Social Aspects of Trust." In Trust in Society, ed. Karen S. Cook, 285-306. NYC: Russell Sage Foundation, 2001.

US Department of Justice. "Child Victims" [article on-line]. Washington, DC: US Department of Justice, 2007, accessed 4 November 2007; available from http://www.ojp.usdoj.gov/ovc/publications/infores/firstrep/chldvics.html; Internet.

US National Cancer Institute. "Pituitary Gland" [article on-line]. Atlanta, GA: Emory University, 2007, accessed 21 October 2007; available from http://training.seer.cancer.gov/module_anatomy/unit6_3_endo_glnds1_pituitary.html; Internet.

Vancouver General Hospital. "Oxytocin." [article on-line]. Vancouver: Vancouver General Hospital, 2007; accessed 13 October 2007; available from http://www.vhpharmsci.com/PDTM/Monographs/oxytocin.htm; Internet.

Vazdarjanova, Almira. "Chasing 'Fear Memories' to the Cerebellum." *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 12 (11 June 2002): 7814-7815.

Vecchi, Gregory M. "Hostage/Barricade Management: A Hidden Conflict Within Law Enforcement." [article on-line] Washington, DC: Federal Bureau of Investigations, 2002, accessed 4 November 2007; available from http://www.au.af.mil/au/awc/awcgate/fbi/hostage_mgt.pdf; Internet.

Veenema, A. H. "Opposite Effects of Maternal Separation on Intermale and Maternal Aggression in C57BL/6 Mice: Link to Hypothalamic Vasopressin and Oxytocin Immunoreactivity." *Psychoneuroendocrinology* 32, no. 5 (April 2007): 437-450.

Verlegen. "De processen in de hersenen" [article on-line]. The Hague: Verlegen, 2007, accessed 21 October 2007; available from www.ikbenverlegen.nl/afbeeldingen/amygdala.jpg; Internet.

Vishwajeet, Singh and Aneesh Srivastava. "Water Intoxication Leading to Hyponatremia and Seizures: A Rare Complication of Uroflowmetry." *International Urology and Nephrology* 47, no. 2 (June 2005): 275-276.

Vogt, R. L., L. Witherell, D. LaRue and D. N. Klaucke. "Acute Fluoride Poisoning Associated with an On-site Fluoridator in a Vermont Elementary School." *American Journal of Public Health* 72, no. 10 (October 1982): 1168-1169.

Walker, John R. and George F. Koob. "Orphan Anxiety." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 26 (23 December 1997): 14217-14219.

Wang, Jenn Yeu, Shih Hua Lin, Yuh Feng Lin, Hui Yen Chen, Fu Chiu Yu, Mao Tsu Fu. "An Unforgotten Cause of Acute Hyponatremia: Water Intoxication due to Oxytocin Administration in a Pregnant Woman." *Nephron* 86, no. 3 (April 2000): 342-343.

Wang, Rex Y. and George K. Aghajanian. "Physiological Evidence for Habenula as Major Link Between Forebrain and Midbrain Raphe." *Science* 197, no. 4298 (1 July 1977): 89-91.

Wanjek, Christopher. *Bad Medicine: Misconceptions and Misuses Revealed, from Distance Healing to Vitamin O*. Hoboken, NJ: Wiley Publishing, 2002.

Weingartner, Herbert, Philip Gold, James C. Ballenger, Sheila A. Smallberg, Richard Summers, David R. Rubinow, Robert M. Post and Frederick K. Goodwin. "Effects of Vasopressin on Human Memory Functions." *Science* 211, no. 4482 (6 February 1981): 601-603.

Wersinger, S. R., K. R. Kelliher, F. Zufall, S. J. Lolait, A. M. O'Carroll and W. S. Young, III. "Social Motivation Is Reduced in Vasopressin 1b Receptor Null Mice Despite Normal Performance in an Olfactory Discrimination Task." Hormones and Behavior 46, no. 5 (December 2004): 638-645.

Xuan-shi, Lim. "A Closer Look at the Familiar: What Do We Know About Trust?" [article on-line]. Philadelphia, PA: Bryn Mawr College, 2007, accessed 27 October 2007; available from http://serendip.brynmawr.edu/bb/neuro/neuro05/web3/xlim.html; Internet.

Zald, David H. and Jose V. Pardo. "Emotion, Olfaction and the Human Amygdala: Amygdala Activation during Aversive Olfactory Stimulation." *Proceedings of the National Academy of Sciences of the United States of America* 94, no. 8 (15 April 1997): 4119-4124.

Zhou, J. N., M. A. Hofman and D. F. Swaab. "No changes in the number of vasoactive intestinal polypeptide (VIP)-expressing neurons in the suprachiasmatic nucleus of homosexual men; comparison with vasopressin-expressing neurons." Brain Research 672, no. 1-2 (20 February 1995): 285-288.

Zukin, Stephen R., Anne B. Young and Solomon H. Snyder. "Gamma-Aminobutyric Acid Binding to Receptor Sites in the Rat Central Nervous System." *Proceedings of the National Academy of Sciences of the United States of America* 71, no. 12 (16 December 1974): 4802-4807.

# INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California